Instruction Manual
EBPS 6/10/15/20 Electron Beam Power Supply

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Danger – High Voltage!

High Voltage is present within the equipment. Care should be exercised at all times when operating or troubleshooting.

Human contact with the voltages present within the equipment can be fatal. Make sure to turn off the input power before opening the doors or panels. Short all capacitors with a grounding hook. Avoid testing live circuits.

If, in the process of troubleshooting it becomes necessary to energize portions of the circuitry, extreme caution should be observed. All test meter connections should be made with the power off. The test leads should be in good repair and have sufficient insulation for at least twice that to be measured. The test meter should not be touched after the power is turned on. Do not work in cramped spaces or cluttered areas. Only highly experienced personnel utilizing standard approved safety procedures should carry out troubleshooting of this nature.

Danger – High Voltage!

WARNING

Tetrode Tube must be installed prior to operation of power supply.

Read complete instruction manual before operation.

Tetrode tube installation:

1. Remove top cover of main power supply cabinet.
2. Locate tube socket (inside PVC air duct tube)
3. Holding tetrode tube; align it with tube socket and with a firm downward twisting motion mate the tube with the socket.
4. Attach the anode clip connector to the top (anode) of the tetrode tube (plate cap)
5. Install top cover of the main power supply cabinet. Be sure the exhaust fan 4 wire connector is connected to it's mating connector.
6. After installation is complete turn on the front panel MAIN, CONTROL AND TETRODE circuit breakers. With the **high voltage OFF** let the supply run for **30 minutes** or more to warm up the tube. The power supply is now ready for operation.

This initial warm up / break in period for the tetrode tube is only required the first time the supply is turned on. A **5 minute** warm up period is recommended each time the supply is turned on to maximize tube life.

Normal Shut Down procedure

1. Turn off E-B source circuit breaker
2. Turn off tetrode tube circuit breaker
3. Leave in this mode (fan running) for **5 minutes** -or- until the exhaust air from the top panel tube fan is cool.
4. Turn off control and main circuit breakers

Warranty Statement

Thermionics warrants each item it manufactures to be free from defects in workmanship and material for a period of one year from date of shipment. HM2 e-Gun evaporation sources are warranted for a period of five years from date of shipment. Minor deviations which do not affect the performance of the equipment shall not be deemed to constitute defects of workmanship or materials, or failure to comply with the specifications.

Notwithstanding the foregoing, Thermionics shall have no warranty responsibility for expendable items such as vacuum tubes, diodes, transistors, batteries, lamps, mechanical pump shaft seals and oil, diffusion pump oil, gaskets, of filaments. In addition, all vacuum gauge sensing devices such as thermocouple tubes, Pirani tubes, ionization gauge tubes, etc. are warranted against defects in manufacture in normal use, as determined be seller's inspection, for a period of ninety (90) days from date of shipment, provided the defective gauge tube is returned to the seller's plant for inspection.

Equipment made or modified to Purchaser's specifications on special orders shall carry the above warranties with respect to material and workmanship, but shall be specifically excluded from any other warranties, express or implied, including those related to performance specifications, and any special components manufactured by others shall carry only the original manufacturer's warranties.

This warranty does not extend to and Thermionics products which have been subject to misuse, neglect, accident, or improper application, not shall it extend to units which have been substantially altered outside the Seller's plant except by a Thermionics service engineer.

This warranty is expressly in lieu of all other obligations or liabilities on the part of Thermionics unless such additional warranty is either agreed to in writing, appears in a separate warranty statement provided to the customer, or appears in a warranty statement accompanying the product shipped to the customer. Under no circumstance will Thermionics be liable for consequential or resulting less or damage, whether of not due to causes covered by Thermionics' warranty. Thermionics neither assumes nor authorizes any other person to make any other representation or warranty on its behalf, or assume for it any liability in connect with the sale of its products.

WARRANTY REPAIR

Notice of any claim that a product is in any way defective shall be given to Thermionics immediately upon discovery. Before any items are returned for repair and/or adjustment, approval of Thermionics must be obtained by the customer. Written authorization for the return and instructions as to how these times should be shipped will be provided. If any Thermionics products must be returned to the factory, they must be sent prepaid via the means of transportation indicated as being acceptable in the written authorization. Thermionics reserves the right to reject and warranty claim on any product that has been shipped by a non-acceptable means of transportation.

When Thermionics products are returned for examination and inspection, it is important that they be properly packed for shipment. Use the original packing material or equivalent. The sender and the shipping agency must assume the responsibility for damage resulting from improper packing or handling, and for loss in transit.

When products are returned, it is very important that the customer provide Thermionics with the data on the operating conditions and any other pertinent information which will enable us to determine the cause of failure. In all cases, Thermionics has sole responsibility for determining the cause of failure, and sole discretion in determining the nature and extent of adjustment, if any, to which a customer my be entitled.

If it is found that our product has been returned without cause and is still serviceable, the customer will be notified and the product returned. All shipping costs on products returned for warranty repair shall be the customer's responsibility. Thermionics' sole liability hereunder shall be the correction and/or replacement of defective materials and workmanship.

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Section 1

Specifications

1.1 Introduction

The Thermionics Laboratory Inc. Model EBPS 6/10/15/20 Power Supplies provide the accelerating high voltage for the electron beam guns. They differ only by the maximum output power capability. Included in each power supply are the circuits required for the control and monitoring of one electron beam gun. If multiple gun operations are required, it is only necessary to obtain additional gun controllers and sweepers.

1.2 General Description

The EBPS 6/10/15/20 Electron Beam Power Supplies consist of the following:

One high voltage power supply with tetrode regulator.
One high voltage control chassis.
One filament controller (located in HV control chassis)
One filament transformer enclosure.

1.3 High Voltage Power Supply

Model	EBPS6	EBPS10	EBPS15	EBPS20
Input Power (vac) 3 phase, 50/60 Hz	208/240	208/240	208/240	208/240
Input Current (max amps)	30	40	55	70
Output Voltage (max kvdc rms)	7	10	10	10
Output Current (max amps)	. 85	1.0	1.5	2.0
Output Ripple (max vrms)	100	100	100	100
Current Cutback Level (amps)	.2-3	.2-3	.2-3	.2-3
Cutback Response (msec)	10	10	10	10
Dimensions:	24" wide x 36" deep x 34" high			

1.4 Filament Controller

The filament controllers for the three power supplies are identical.

Specifications:

Input Voltage:	240 volts single-phase, 50/60 Hz
Primary Control:	SCR, phase-angle control
Output Voltage:	0 – 240 volts
Output Current:	5 amperes max
Regulation:	Less than 2%
Dimensions:	9 ½" wide x 21" deep x 5 ½" high

1.5 Filament Transformer Enclosure

The filament transformer enclosure is identical for the three power supplies.

Specifications:

Primary Voltage:	208/240 volts, single-phase, 50/60 Hz
Secondary Power:	10 volts, 70 amperes maximum
Insulation:	The secondary is insulated from the primary and core (ground) by 15KVDC working.
Dimensions:	11" wide x 18" deep x 11" high

1.6 Sweep Generators

Two models of beam positioning controls are available. The specifications for each and listed in the following sections.

1.6.1 Triangular Controller, Model XYS

The output waveshape of both channels of the XYS sweeper is triangular and Independently controlled. With the position controls, the beam can be positioned anywhere over the entire surface of the crucible. A variable amplitude / frequency triangular waveshape can also be applied to the coils.

Specifications:

Input Power:	115 volts, single-phase, 50/60 Hz
Input Current (max):	2 amperes
Output Voltage (max):	+/- 30 volts DC
Output Current (max):	+/- 2 amperes DC
Frequency:	Variable 5 to 200 Hz
Dimensions:	9 ½" vide x 21" deep x 5 ½" high

1.6.2 Circular Controller, Model XYSC

The model XYSC sweeper provides sinewave drive to longitudinal and lateral coils of the gun. These waves are separated by 90 electrical degrees so that the resultant beam path is circular. By adjusting the amplitude of the waves, the diameter of the circle is changed. A triangular shaped modulating wave is applied to the amplitude control such that the resulting beam expands and contracts in a linear manner. With this sweep, the entire surface of the crucible can be swept with no discernible hot spots.

Specifications:

Input Power:	115 volts, single-phase, 50/60 Hz
Input Current (max):	2 amperes
Output Voltage (max):	+/- 30 volts DC
Output Current (max):	+/- 2 amperes DC
Sinewave Frequency:	100 Hz
Modulating Frequency:	Variable 1 to 20 Hz
Dimensions:	9 ½" wide x 21" deep x 5 ½" high

Section 2

Theory of Operation

2.1 Introduction

This section contains a detailed description of the circuits contained in the EBPS 6/10/15/20 Power Supply, the filament controller and the beam position sweepers. This section should be read and understood prior to installing or operating the power supply.

2.2 AC Power Distribution

The AC power distribution is shown in the wiring diagrams for the power supply (193-100-014) and the PC board chassis (193-100-033).

The primary power cable passes through a hole in the bottom of the rear side of the cabinet and is connected to CB1, the MAIN POWER circuit breaker. In Addition to the three AC power wires, a source ground wire must also be provided. This wire is connected to the cabinet structure. The primary power required by the system is 208/240 volts, three-phase, 50/60 Hz. The AC source must be capable of supplying a maximum current shown in the table of Section 1.

Single-phase power for the control circuitry is taken from the output of CB1 and applied to CB2, the CONTROL circuit breaker. It's output is then applied to the AC distribution transformer (UD200/T201) which is mounted on the tetrode deck. The 115-VAC output of this transformer is protected by a string of fuses, which are located behind the top panel of the cabinet.

Power for the tetrode and gun circuits is taken from the output of the MAIN circuit breaker and applied to individual circuit breakers. They are mounted on the lower front panel of the supply and labeled accordingly.

2.3 High Voltage Power Supply

The output of CB1 is applied to the high voltage contactor (CON1). The contactor provides on-off control of the high voltage power supply. When CON1 is energized, AC power is applied to the primary of the rectifier transformer (T1).

The output of T1 is connected in wye and applied to a conventional fullwave bridge rectifier composed of D1 through D30. The output of the rectifier is approximately –8.5 kVDC for the 6KV-power supply and –12.5 kVDC for the larger models. The output of the bridge is connected to a filter capacitor (C1) through 50-ohm resistors (R1 and R2). A bleeder resistor (R3 through R7) is connected across C1 and its purpose is to discharge the stored energy when primary power is removed from T1.

The positive output of the high voltage power supply is connected to the anode of the tetrode (V1). Closed loop control of the voltage drop across V1 provides the required voltage regulation for the electron beam gun. This is not the most important function of V1, however. It also disconnects the electron beam gun from the high voltage power supply during the frequent and random arcs that occur during normal operation. When an arc occurs, the current cutback circuit provides a signal that turns the tetrode off extinguishing the arc. A detailed explanation of the regulator and current cutback circuits is provided in the following section.

The cathode of V1 is connected to ground through a current shunt (R16). This resistor provides the signal for the current cutback circuit. The negative output of the power supply is connected to the electron beam gun and its return is supplied by the tank ground. Under normal conditions, negative 7 kilovolts (-10Kv for the 10, 15, and 20 kW models) is supplied to the source, and 1KV is dropped across the tetrode. A bleeder resistor composed R8 through R12 is connected across the output of the supply. Its purpose is to discharge the capacity of the output cable and gun filament transformer when the power supply is turned off. A high voltage divider (R14 and R15) is connected across the output and its function is to provide the feedback signal for the voltage regulator circuit.

2.4 Tetrode Regulator

This section contains a detailed description of the operation of the tetrode regulator and its associated circuits. Reference is made to the simplified block diagram of figure 2-1.

2.4.1 Grid Power Supplies and Cathode Circuit

An Eimac 4CX5000A High Power Tetrode is used as the series element in a conventional series tube voltage regulator configuration (a 4CX15, 000A tetrode is used in the 10, 15 and 20KW models). It also provides a means of interrupting the short circuit resulting from high voltage arcs. The cathode of the tube circuit is connected to ground and its anode is connected to the positive side of the power supply.

The tube cathode connection is taken from the center tap of the filament transformer. This connection cancels the effect of the AC current applied to the filaments. The tube cathode is connected to ground through R16, the high voltage power supply current shunt. The voltage developed across this resistor is proportional to the power supply current and is used by the current cutback circuit. The control and screen grid power supplies are referenced to the ground side of this resistor.

> Caution!
>
> The Tetrode and its associated circuits are connected to high voltage. Be sure that all power is removed prior to performing maintenance or making measurements. Always short the components that you are going to touch with a shorting rod before you make contact with the component.
>
> Caution!

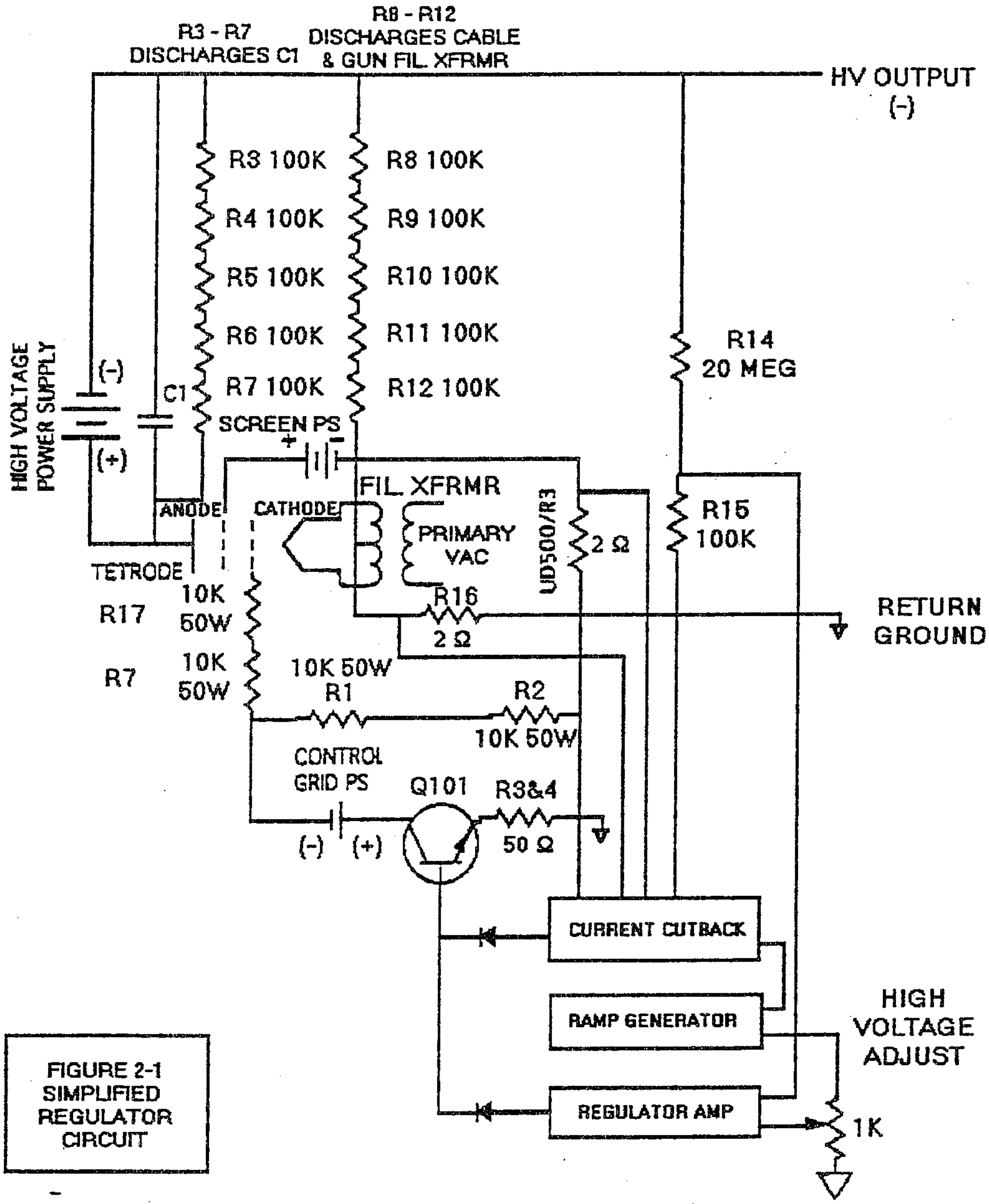


FIGURE 2-1
SIMPLIFIED
REGULATOR
CIRCUIT

The screen grid power supply obtains its power (115 VAC) through F304 (Refer to DWG 193-100-033 and 193-999-023). The secondary output of the rectifier transformer (UD500/T1) is applied to a conventional full-wave bridge rectifier composed of 12 individual diodes. The output of the rectifier is filtered by a choke input filter and its output is then applied to the screen of the tetrode through R18. The negative output of the power supply is connected to the cathode through a 2-ohm resistor (UD500/R3). The voltage developed across this resistor provides the signal for the second channel of the current cutback circuit, the operation of which will be described later. A power supply bleeder is connected across the filter capacitor so it will discharge when the power supply is turned off. This resistor also provides a low impedance path for the screen current in the event that the screen emits electrons. If this resistor were not there, screen emission would cause screen voltage to increase, which in turn would cause increased dissipation, and thus increased emission. A runaway condition would result. The normal value of the voltage is 250 volts for the EBPS6 and 500 volts for the larger supplies.

Primary power for the control grid power supply is applied to the primary of the rectifier transformer (UD600/T1) through F303. The secondary output of T1 is then connected to a fullwave bridge rectifier, the output of which is then filtered be a choke-input filter. A bleeder is connected across the filter capacitors to insure that they will be discharged when primary power is removed. The DC output of the supply is approximately 250 volts for the EBPS6 and 500 volts for the larger units. Both outputs are isolated from ground and are applied to the control grid driver circuit.

The method of generating control grid drive is best seen by referring to the circuit of figure 2-1, and the schematic for the control grid driver printed circuit board (193-100-802). The negative output of the control grid power supply is connected to the tetrode through a 10K resistor and R7 (mounted on the PC board). The positive output is connected to the collector of Q1 through pin 1. The emitter of Q1 is tied through R3 and R4. A 20-kilohm resistor is composed of R1 and R2 connected in series and connected from ground to the negative output of the control grid power supply. When Q1 is forced into conduction, current passes from the positive output of the power supply through Q1, through the 40K resistor and returns to the negative side of the supply. This current develops a voltage drop across the resistor such that a negative voltage (referenced to ground) is applied to the control grid of the tetrode. An increase in the current passing through Q1 increases the bias voltage applied to the tetrode, and it is turned off. The following sections describe the operation of the circuits that control the base drive of Q1.

2.4.2 Voltage Regulator Circuit

This section contains a detailed description of the regulator loop. Later sections will describe the operation of each printed circuit board within this loop. Refer to figure 2-1 in the following description. A high voltage divider consisting of a 20 megohm resistor and a 100 kilohm resistor is connected between the negative high voltage output and ground (R14 and R15). The voltage developed across R15 is used as the feedback signal for the regulating loop.

A ramp generator, the quiescent output of which is approximately 10 volts positive, provides the required voltage for the VOLTAGE ADJUST potentiometer located on the control panel. Its output provides the reference signal to the regulating amplifier. The output of the ramp generator is "reset" by a signal from the current cutback circuit. Under normal operation, the output is constant and the system is voltage regulated. During a current cutback, the ramp is reset to zero and its output is held at this potential until the cutback period is over. At this time the ramp generator begins is cycle. The output is exponentially ramped to its quiescent level, causing the output voltage to rise in the same manner.

An operational amplifier within the regulator amplifier circuit sums the feedback and reference signals such that its output provides the error signal for the regulating loop. This signal provides the base drive for Q1.

Assume that the system is operating at a quiescent level of 10 kilovolts output. This would correspond to a feedback signal of (-) 5 volts. This signal is amplified and is used as the feedback signal. For this output, the reference signal must be approximately (+) 10 volts. Now assume that the input voltage to the system suddenly increases, resulting in an increase in output voltage. The resulting increased error signal causes the current through Q1 to increase, which in turn increases the voltage drop across the 20K power resistor. The increased negative bias on the control grid of the tetrode increases the anode-to-cathode voltage drop, which in turn reduces the output voltage. Compensation for the original increase in supply voltage is therefore provided by action of the regulating loop.

The operation of the ramp generator and voltage regulator printed circuit boards will now be presented.

2.4.3 Ramp Generator

Refer to the ramp generator printed circuit board schematic diagram (193-100-702) in the following discussion. The signal from the current cutback circuit is 10 volts positive when operational and zero when a cutback condition exists. This signal is applied to the base of a NPN transistor (Q1). With this base drive, the transistor is turned on with normal operation and off in cutback. The collector signal is applied to the non-inverting input of an operational amplifier (A1), which is connected as a comparator. When Q1 is turned on (normal operation), the output of A1 is negative and when Q1 is turned off, the output of A1 swings rapidly positive. This positive signal is applied to the gate of Q2, and N-channel VMOS power FET, and it is turned on. The signal at the drain of Q2 swings to zero and it will remain so until the output of A1 again swings negative. This action turns Q2 off and a capacitor (C1) connected to its drain is allowed to charge through R8. A zener diode (CR2) clamps the voltage across C1 to 10 volts positive. It will remain in the condition until "reset" action takes place. The voltage across C1 provides the output of the ramp generator.

2.4.4 Regulator Amplifier

A schematic diagram of the regulator amplifier printed circuit board is shown in drawing 193-100-852. Refer to it in the following discussion.

The feedback signal from the voltage divider is applied to the board through pin 8. This signal is applied to the inverting input of an operational amplifier (U1), the gain of which is two. The positive output of U1 provides the feedback signal to the inverting summation amplifier, U2. Its output, designated the error signal, is applied to an inverting amplifier (U3), the output is applied to the base of an NPN transistor (Q1). The signal at the emitter of Q1 is then coupled to pin 18 through a series diode, CR6.

The output of U1 is also applied to the inverting input of U4 through a 10K-resistor (R16). The inverted output signal of U4 is then connected to the base of

Q2, a power PNP transistor, connected in an emitter follower configuration. The signal at the emitter of Q2 is fed back to the input of U4 through a 10K-resistor (R19). The purpose of this circuit is to provide an output signal, which varies from zero to 10 volts negative for an input variation to the PC board from zero to 5 volts negative. The filament controller uses this signal and its function is described later. It is also used to drive the OUTPUT VOLTAGE meter located on the control panel.

The second input of the summing amplifier (U2) is provided by the ramp generator and the position of the swinger of the VOLTAGE ADJUST potentiometer. The signal from this potentiometer is applied to the regulator board through pin 3. This signal is applied to the non-inverting input on an operational amplifier (U5), which is connected as a voltage follower. Its output is then connected to a unity gain inverting amplifier (U6), the output of which is connected to the summing junction of U2 through R15.

When the high voltage power supply is turned off, no anode voltage is applied to the tetrode. Then this occurs, the regulating loop attempts to increase the output voltage by decreasing the control grid bias voltage. This would cause the screen grid to conduct heavily and the system would go into cutback because of the resultant excessive screen current. For this reason, the action of the regulating loop is disengaged by inserting a positive signal through the normally closed contacts of the high voltage control relay (K1). This positive signal is inserted into the regulating loop through pin 14 and R1. Thus when the high voltage is turned off, the positive signal causes the output of U2 to swing negative which in turn causes a positive signal at the base of Q1. The resulting signal turns the tetrode drive transistor on and the resulting negative bias turns the tetrode off. When the high voltage power supply is turned on, the contacts on the control relay open and the positive signal is removed from the input to the regulator amplifier. The regulating loop is then allowed to operate normally.

2.4.5 Current Cutback Circuit

The schematic diagram for the current cutback circuit is shown in drawing 193-100-752.

As mentioned earlier, it is normal for the tetrode to be subjected to repeated load arcs. It is necessary, therefore, that the current be controlled during these arcs and that the applied voltage be reduced to extinguish the arc. It is also required that this be done with no interruption in system operation. The circuit that satisfies this requirement is the current cutback circuit.

When a high voltage arc occurs, a large amount of current passes from the power supply, through the arc to the tetrode. The amplitude of this current is limited only by the tetrode and the impedance of the power supply. It is several times that of normal operation. When this happens, the voltage drop across the shunt resistor located in the cathode circuit of the tetrode circuit increases rapidly, providing the input signal to the cutback circuit.

The positive signal from the current shunt is applied to the circuit through pins 10 and 12. It is applied to the inverting input of the comparator (U1). Adjustment of the point at which the output of U1 switches is controlled by the second input through pin 8. The amplitude of the signal is determined by the position of the swinger of the EMISSION CURRENT LIMIT potentiometer. If the positive signal from the shunt resistor is greater than the positive signal from the potentiometer, the output of U1 swings negative. This output is applied to a debouncer integrated circuit (U7), the purpose of which is to remove transients from the output of U1. The output of U7 swings from high to low when an input signal switches the comparator. This signal is applied to the input of a dual monostabel multivibrator (U4) through one of the gates of U3. This gate switches its output from high to low whenever either channel of the circuit switchers. The signal is then applied to the multivibrator through pin 1. The second input (pin 2) is connected to its inverting output such that it is held high when the circuit is in its normal condition. One way of triggering U4 is by holding pin 2 high and switching pin 1 from high to low. The multivibrator is then triggered into its cycle and its output is applied to another gate of U3. The length of the output pulse from U4 is determined by the time constant of R18 and C4. Its output pulse width is set approximately 50 milliseconds. Following this period, the multivibrator must be provided a short time to reset before it can be re-triggered. This is accomplished by the second monostable multivibrator of U4. The inputs of the multivibrator are connected such that it switches at the end of the first multivibrators period. The second pulse width is also determined by a RC time constant (R20 and C5), and is set to approximately 10 microseconds. This time is sufficient to reset the first multivibrator. The inverted output of the second multivibrator is applied to the second gate of U3.

The output of the gate swings low to high when the first multivibrator switches and will remain in this condition throughout the period of the pulse. At the end of the pulse, the second multivibrator switches, causing the output of the gate to return to zero. If the shorted condition exists following the second period, the first multivibrator will trigger and the action will repeat. Under continuous shorted conditions, the output of the gate will be a train of positive pulses, the duty of which will be very low (50 milliseconds on and 10 microseconds off). This output is then applied to the input of an array of Darlington transistors (U5).

One of the transistors is used to drive the light emitting diodes mounted on the PC card and the high voltage control panel. They are provided to give an indication of the occurrence of an arc. The LED's will energize when the circuit is triggered.

The second transistor is used to provide a signal for the cutback operation of the tetrode. A series resistor (R22) limits the current through a zener diode and their junction is connected to the gate of Q1, a VMOS power FET. The normal positive signal at the collector of the second transistor of U1 turns Q1 on and the signal at its drain is zero. When U1 is turned on, the gate signal of Q1 is removed and it is turned off. This results in a positive signal applied to the board output at pin 14 through CR15. The positive output signal is applied to the base of the tetrode drive transistor and the tetrode is turned off. When the cutback circuit returns to its normal state, Q1 is again turned on and the voltage-regulating loop takes control.

In a like manner, the ramp generator receives its reset signal from the third Darlington of the array. The signal at its collector is applied to the input of the gate such that it is positive 15 volts when the cutback circuit is in its normal state and zero when it is re-triggered. The way that a signal is used is described in an earlier section.

The second channel of the cutback circuit obtains its input signal from the shunt resistor located in the return leg of the tetrode screen grid power supply. Its operation is identical to that described above.

2.4.6 Tetrode Filament Power

The tetrode is air cooled and capable of dissipating 5 kilowatts (15 kW for the larger models) with sufficient air passing through it. A high-pressure blower (B1) is provided to supply the tube with this airflow. The blower takes air from the room and pressurizes the plenum on which the tube is mounted. The socket and associated air chimney directs the air through the tube is sufficient quantity to cool the tube for all operating conditions. If for some reason power is removed from the blower, high voltage and filament power must be turned off.

A pressure sensitive switch (S4) is mounted of the tetrode plenum such that it senses the pressure developed by B1. If B1 is energized, developing pressure within the plenum, the contacts of S1 close and K2 is energized. One set of normally open contacts of this relay are inserted in the high voltage interlock string and the second set energizes the tetrode filament power contactor (CON2). If power is removed from the blower, K2 is de-energized resulting in the removal of high voltage and filament power.

2.5 High Voltage Power Supply Interlocks

As mentioned earlier, personnel and equipment are protected from inadvertent application of high voltage by a string of interlocks. This section contains a functional description of each interlock. Refer to the wiring diagram for the remote control panel (DWG 192-017-054) and the printed circuit chassis (DWG 193-100-033).

Control power (115 VAC) is applied to the primary of T301 through the CONTROL fuse (F301). The negative output of the power supply is connected to the chassis (ground) and the positive 24-volt output provides system control power. The function of each high voltage interlock is described in the following section.

2.5.1 Control

The first indicator of the high voltage interlock string (LT901) is labeled "CONTROL". It is provided to give indication that the control power supply is energized and that 24-volt control power is applied to the system.

2.5.2 Vacuum Interlock

This is the first interlock of the string. It is provided to insure that there is sufficient vacuum in the tank before high voltage and gun filament power can be turned on. This point normally coincides with the energizing of the vacuum gauge filaments and most gauges have auxiliary contacts for this purpose. The connection should be made through terminals 1 and 2 of TB901. The interlock acts as the first interlock in both the high voltage and gun filament interlock strings. LT902 and 911 indicate the condition of the interlock.

2.5.3 Cabinet Air Interlock

This interlock provides protection for the tetrode by insuring that the tetrode blower is energized before filament power and high voltage can be applied to the tetrode. As described earlier, a pressure sensitive switch senses the tetrode plenum pressure to insure adequate tetrode cooling. This action energizes the interlock relay (K2) and its normally open contacts provide the interlock function. The TETRODE interlock light (LT903) indicates the condition of the interlock.

2.5.4 External Interlock

This interlock is provided so that the user supplied interlock string can be conveniently added to the high voltage interlocks. This is accomplished by connecting the external interlock string to terminals 3 and 4 of TB901.

2.5.5 Key Interlock

This interlock is provided so that the high voltage on/off controls can be locked out. In this condition, the high voltage cannot be turned on. LT905 indicates the condition of this interlock.

2.5.6 HV Ready Indicator

When all of the high voltage interlock lights are energized, the high voltage is ready to be turned on. The HV READY light (LT906) will indicate this condition. The on/off control circuits will be described in the following section.

2.6 High Voltage On-Off Control

This section provides an operational description of the on/off control of the high voltage power supply. Refer to drawings 193-017-054 and the simplified drawing of figure 2-2.

Control power (24 VDC) is applied to the vacuum interlock, the first interlock of the high voltage and gun filament chains. It is then applied to the cabinet air interlock. The next interlock is the external interlock and its output is applied to the "HV OFF" pushbutton through the operating mode relays (K901 and 2). The output of these relays is then applied to the "HV OFF" pushbutton (S902). Its output is then connected to the "HV ON" pushbutton, the output of which is connected to the coil of K903. When the "ON" pushbutton is depressed, K903 is energized and it is held in this condition by a set of its own contacts. If the interlock string is broken or the OFF pushbutton is depressed, the hold circuit is interrupted and K903 are used to energize K1, located in the power supply cabinet and the high voltage contactor is closed.

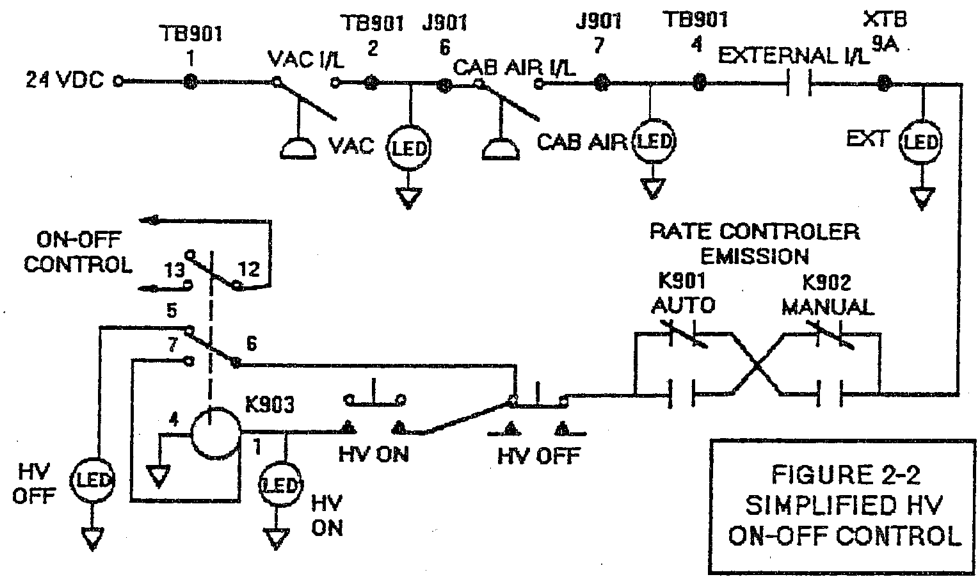


FIGURE 2-2
SIMPLIFIED HV
ON-OFF CONTROL

2.7 Gun Filament Power Supply

This section contains a detailed description of the operation of the gun filament power supply. Reference is made to the simplified block diagram of figure 2-3 and drawings 193-100-014, 192-017-054, and 192-017-073.

The input power required by the filament circuit is 208/240 volts, single-phase and it is applied to the filament contactor, UD800/K1 through pins 1 and 2 of P801. This contactor provides on-off control for the filament supply. Power control is provided by a phase-controlled SCR and its output is applied to the primary of the gun filament transformer. The gun filament transformer must be capable of providing the required filament current and it must also isolate the electron beam voltage. The transformer is designed to provide a maximum of 10 volts rms at 70 amperes to the gun. The output of the filament transformer is then applied to the electron beam gun through the tank feedthroughs.

The filament of the electron beam gun is operated in a temperature-limited condition. That is, emission current is determined by the power applied to the filament and this current mush be tightly controlled to keep the emission current constant. A closed loop system which drives the input to the SCR controller provides this control. Its operation will now be described.

A simplified block diagram of the gun filament power supply is shown in figure 2-3. The feedback signal is obtained from the transductor whose output is proportional to the emission current of the gun. This device also drives the gun current meter located on the high voltage control panel.

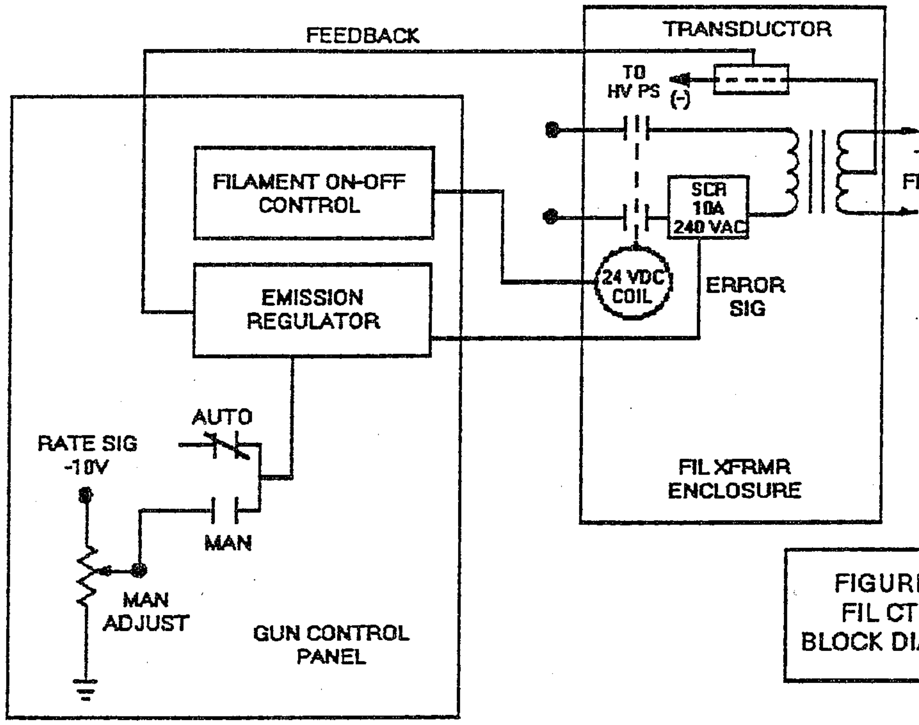


FIGURE 2-3
FIL CTRLR
BLOCK DIAGRAM

The feedback signal is compared to a DC signal developed by the EMISSION ADJUST potentiometer and resultant error signal is applied to the SCR controller. The phase-controlled power out of the controller is applied to the filament transformer. When the feedback signal from the transductor is less then the reference signal, the AC power applied to the filament transformer is increased. The increased filament power then causes an increase in emission current.

If the tetrode is turned off, no high voltage is applied to the gun and no emission current can exist. This condition is sensed by the filament control loop and it increases filament power. When high voltage is again applied, the overheated filament would cause a surge in emission current and this would probably result in another cutback period. A circuit is added to the filament controller to keep this from happening. A signal proportional to the high voltage is used to disengage the emission regulator loop when no high voltage is applied to the gun. The filament current is reduced to a level set by the BIAS ADJUST potentiometer whenever the tetrode is turned off or when a cutback condition exists. A description of the circuits that form the filament feedback loop is contained in the following sections.

2.7.1 Input Amplifier Circuit

This printed circuit board contains the current regulator circuitry for the filament control circuit. It is mounted in the control panel and its schematic is shown in drawing 193-100-602.

The DC input from the transductor (0 to +5 volts for 0 to 2 amperes) is applied to the circuit through pin 14 and returned through pin 15. It is connected to a differential amplifier (A1), the positive output of which provides the "feedback" signal for the inverting input of the regulating amplifier (A2). The gain of A1 is 2, therefore the input signal range of A2 is 0 to 10 volts positive with respect to ground.

The reference signal is obtained from the swinger of the EMISSION LEVEL ADJUST potentiometer located on the control panel. Its range is zero to 10 volts negative with respect to ground and is applied to the non-inverting input of a unity gain buffer amplifier (A3). The output of this amplifier provides the second input to the summing junction of A2.

If the gun is energized without high voltage applied, no emission current will result. The current regulator would sense this condition and would increase the applied filament power to that level set by the EMISSION potentiometer. The gun filament would then be overheated and the output of the filament controller would be maximum. To keep this from happening, a circuit is provided that disengages the regulator circuit whenever high voltage is absent from the gun. As described in a previous section, the voltage regulator circuit provides a DC signal, which is proportional to the output of the high voltage power supply. This signal is applied to the filament regulator amplifier through pins 1 and 2. A unity gain inverting amplifier (A6) changes its polarity and it is applied to the non-inverting input of a voltage comparator (A7). The second input of A7 is connected to a voltage divider composed of R27 and R28, the out of which is 3 volts positive. With no high voltage applied, the output of A7 is minus saturation (approximately 14 volts negative). With the high voltage power supply turned on and its output greater that approximately 4 kilovolts, the signal applied to the non-inverting input of A7 is greater then 3 volts and its output swings to positive saturation. This signal is applied to the base of a PNP transistor (Q2), which in turn is connected across a capacitor/zener combination to –15 VDC through R18. With a positive signal applied to the base, the transistor is turned off and the voltage at its collector is clamped by the zener diode (-10 VDC). This signal is applied to the non-inverting input of A5. When the DC voltage drops due to a cutback in operation, the base voltage swings rapidly negative and Q2 is turned on. The signal applied to A5 is then reduced to zero. Following cutback, high voltage is restored and Q2 is turned off. C11 then charges through R18.

The response characteristics of the closed loop are determined by the feedback components of A2 (C27, R7, and R8) and its roll-off has been intentionally set at a relatively low frequency. Therefore the loop response to a step function, such as the removal of high voltage, is relatively slow. The action of the A5 and Q2 speeds up the cutback function of the filament regulator. As mentioned earlier, the normal input signal of A5 is –10 VDC and its output is approximately 12 volts negative. The coupling diode in its output (D6) is back-biased and the circuit is disconnect from the loop. When the input signal of Q2 swings negative and the output of A7 swings rapidly positive and D6 is forward biased. This results in the filament power being reduced to that level determined by the BIAS ADJUST potentiometer. When high voltage is again applied to the gun, Q2 is turned off and its collector voltage rises in response to the RC time constant of R18 and C11. Thus the gun filament is heated relatively slowly to the point at which the regulation loop takes control. This circuit prevents overshoot and a smooth transition between cutback and current regulation.

The feedback and reference signal is summed at the inverting input of A2 and its output provides the error signal of the regulator loop. The signal swings from zero (corresponding to zero emission) to twelve volts positive (maximum emission). This error signal is applied to the inverting input of A4, the output of which is diode coupled to the output of A5. The signal at the cathodes of the two diodes (D5 and D6) swings from zero to minus 12 volts. As mentioned earlier, this signal is zero whenever the high voltage is less than 4 kilovolts.

The error signal is applied to the non-inverting input of A8 and its output is diode coupled (D11 and D12) to the output of operational amplifier A9. The input signal for A9 is obtained from the swinger of the BIAS ADJUST potentiometer which is located on the rear wall of the control chassis. The signal at the anode of D12 swings from 0 to 4 volts negative with an increase in potentiometer position.

The signal at the output of the coupling diodes can swing from a minimum of zero to a maximum of 12 volts negative, the minimum of which is determined by the "BIAS ADJUST" potentiometer. This signal is then applied to the inverting input of operational amplifier A10. Its output is brought out of the board through pin 18. The output swing is 0 to 10 volts positive with respect to ground. This signal is then applied to the input of the SCR controller.

2.7.2 Gun Filament Interlocks

As with the high voltage power supply, the gun filaments are protected by an interlock string. The operation of each is described in the following sections. Refer to DWG 192-017-054 and figure 2-4.

2.7.2.1 Vacuum Interlock

This interlock is shared with the high voltage interlock string. Since it is the first of each string, its output provides control power for both. The normally open contacts of the interlock are connected to terminals 1 and 2 of TB901. When the interlock is closed, LT911 is energized and control power is applied to the two-interlock circuit.

2.7.2.2 Gun Water Interlock

This interlock insures that sufficient cooling water is passing through the electron beam gun before filament power can be applied. It consists of normally open contacts of a flow switch being connected to terminals 5 and 6 of TB901. The GUN WATER (LT912) light will be energized when this interlock is closed.

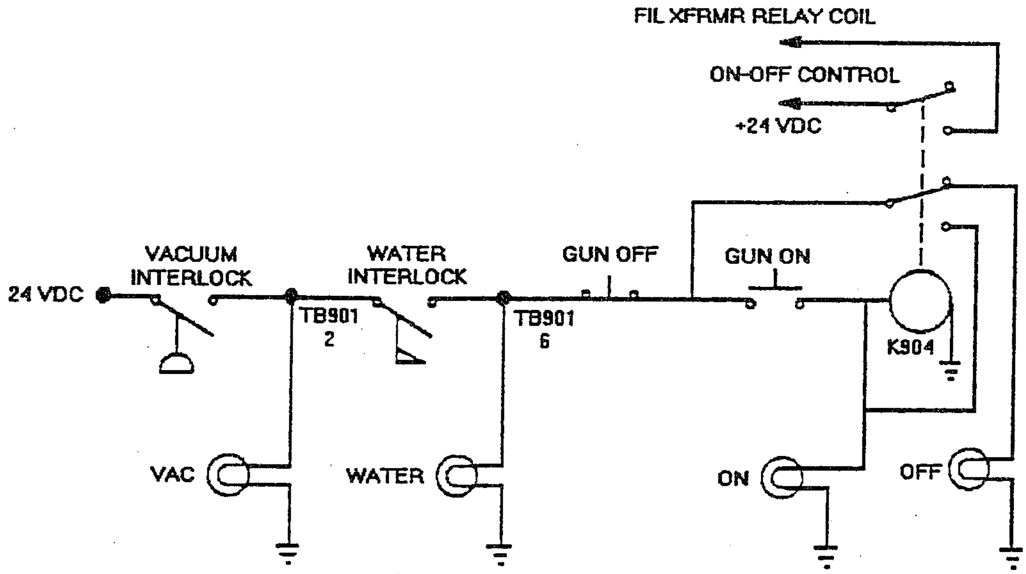


FIGURE 2-4
SIMPLIFIED GUN
ON-OFF CONTROL

2.7.3 Filament On-Off Control

The operation of the on-off control of the gun filament supply is identical to that of the high voltage power supply. The gun interlock string is connected to the "GUN OFF" pushbutton, the output of which is applied to the GUN ON pushbutton. When the "ON" pushbutton is depressed, K904 is energized and it is held in this condition by its holding contacts. When the "OFF" pushbutton is depressed or the interlock string opened, the holding power is removed and the gun filament is de-energized.

When the system is in AUTO control, the rate controller must provide a reference signal to the input amplifier. This is accomplished by applying a negative signal (0 to 10 volts negative) to terminal 8 of TB901. The output of the filament supply will then be increased as the signal is increased. The panel control is inoperable in this mode of operation.

Section 3

Installation

3.1 Introduction

The EBPS 6/10/15/20 Power Supply is self-contained in its own freestanding cabinet. All interlock connections to the vacuum tank are made from a terminal board, which is mounted, on the rear panel of the high voltage control chassis. A description of the installation procedures is contained in this section.

3.2 Mechanical

The cabinet must be mounted on a level foundation capable of supporting a minimum of 400 pounds. There should be ample clearance on all sides to facilitate the removal of panels. Cooling air enters the cabinet through a filtered opening in the rear of the cabinet. To insure sufficient air circulation, it is important that this side be clear of obstacles.

3.3 Electrical

The section contains the information required for the electrical installation of the system. Section 2 should have been read and understood before proceeding.

3.3.1 System Ground *(Important!)*

The ground system is a very important aspect of the installation of the electron beam equipment. The following section contains a description of its installation.

3.3.1.1 Vacuum Tank Ground (FIG 3-1)

The vacuum tank and the power supply must be connected to a GOOD earth ground. Under normal conditions, a good earth ground will consist of a ¾-inch diameter copper-clad rod driver through the floor and into the earth at the tank location. This ground rod should be connected to the vacuum tank and the power supply cabinet by a #6 or larger copper cable (Do not use braided cable). A ¼" stud is provided in the bottom frame of the power supply to facilitate this connection. Do not use braided wire, and take care that the connection to the vacuum tank is made to bare metal (no coatings or paint).

If the equipment is to be installed in the upper floors of a building where this type of grounding system is impossible, the system ground may be accomplished by connecting the vacuum tank to the steel structure of the building. This should be done only after insuring that the building structure itself has a good earth ground. If no building ground exists, rods must be driven in sufficient number and connected to the building structure to insure a suitable ground.

Do not depend on water pipes for the system ground connection. Because of the multiple joints and their associated tape or sealing compound, no assumption can be made as the impedance of the pipe to earth ground. *Keep in mind that this is a high frequency as well as a DC ground.*

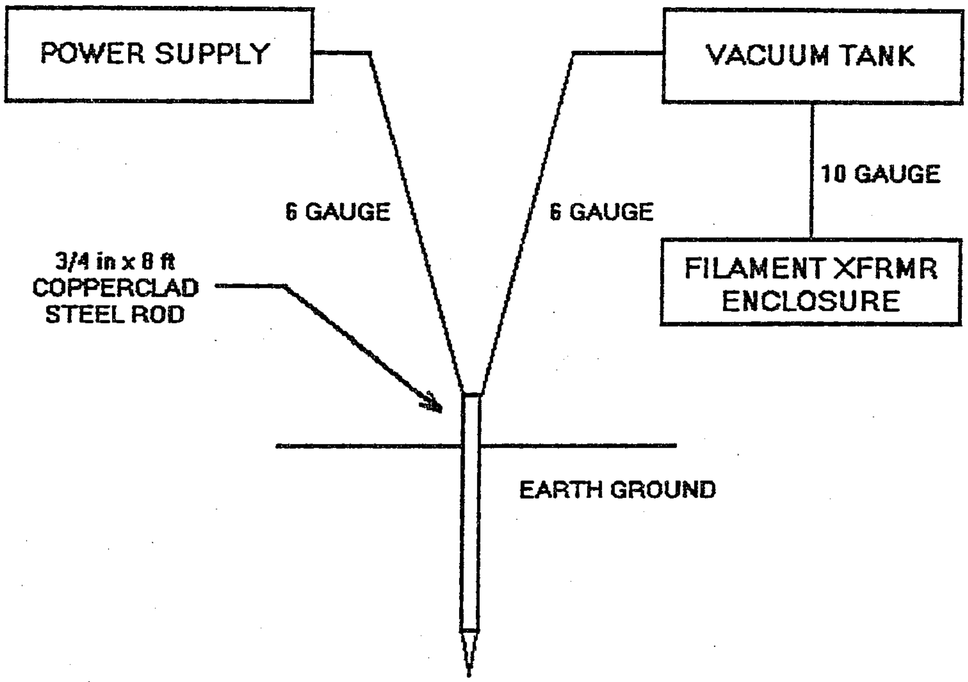


FIGURE 3-1
VACUUM TANK
GROUND INSTALLATION

3.3.1.2 Filament Transformer Enclosure (Fig 3-2)

<u>WARNING</u>

THE TRANSFORMER SECONDARY IS CONNNECTED TO THE HIGH VOLTAGE OUTPUT OF THE POWER SUPPLY. BE SURE THAT THE POWER SUPPLY IS TURNED OFF BEFORE CONNECTING FEED-THROUGHS. DO NOT RELY SOLELY ON THE INTERLOCK SYSTEM.

The filament transformer is mounted in an enclosure, which must be mounted on the tank support structure near the gun feedthroughs. The enclosure should be mounted, and the ground connected to the ground stud provided. This will insure that the box is well grounded to the tank structure. The purpose of the box is to protect personnel from coming in contact with the high voltage present on the transformer secondary. Shielded leads are provided for connection for the transformer enclosure to the power supply.

3.3.1.3 High Voltage Cable

Refer to figure 3-2 (page 3-4). A length (approximately 12') of coaxial high voltage cable is provided for connection of the power supply output. One end of this cable is terminated within the transformer enclosure, and its free end passes through the bottom rear panel (strain reliefs provided). The shield is connected to the stud, which mounts the filter capacitor and the center conductor is connected to the isolated stud provided (located on a red glass channel for isolation). Additional transformer enclosures are mounted in a similar fashion.

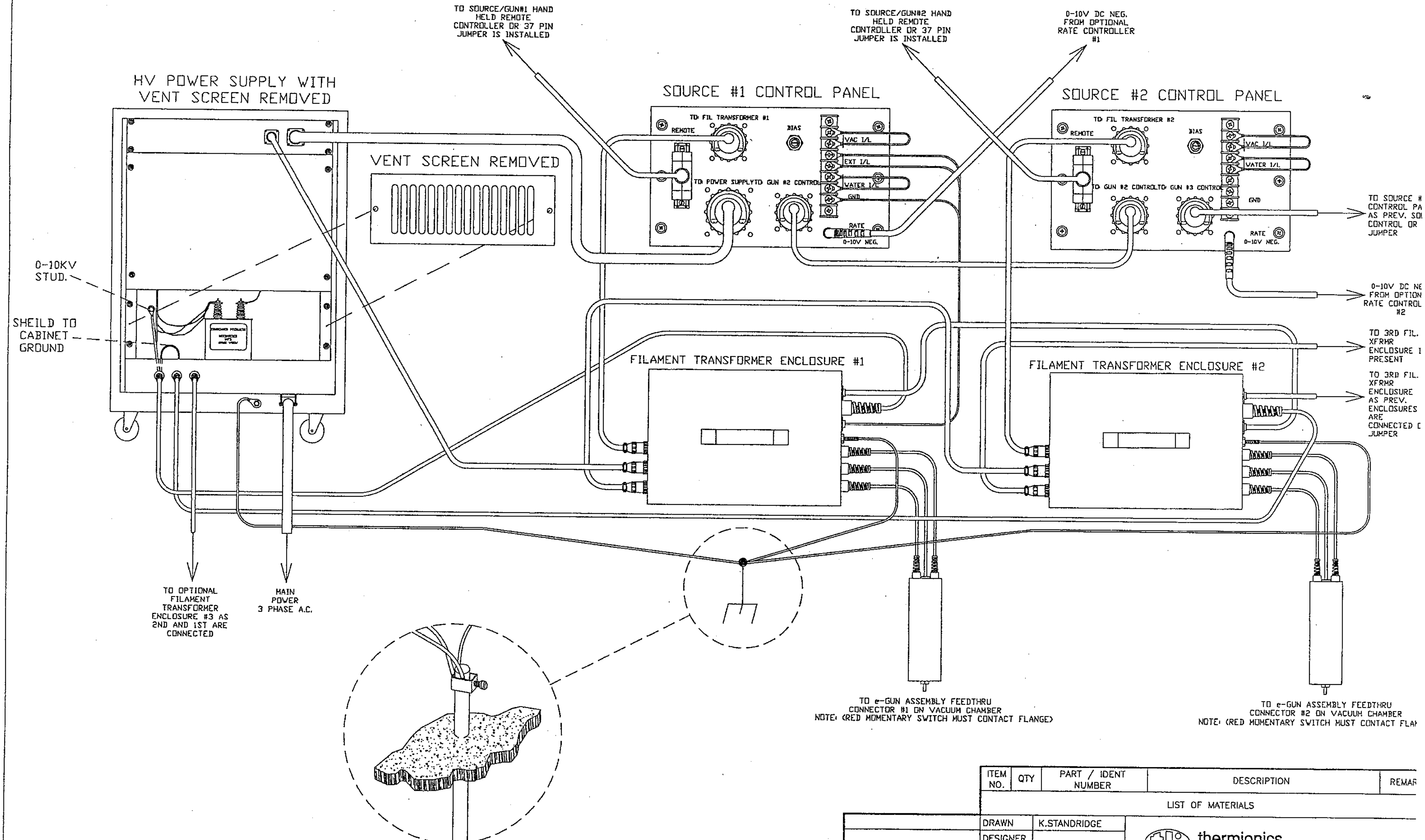
3.3.2 Filament Transformer Primary and Control

A control cable is provided for connection of the filament transformer enclosure to its control circuits. Connection is made by mating the cable to the eight-pin receptacle provided on the transformer enclosure. The free end of the cable is then connected to the similar receptacle on the high voltage control panel. The second (and third of more) transformer enclosures are connected to their associated control panels in a similar manner.

Primary power (208/240 VAC) for the filament transformer is obtained from the power supply. Connect the applicable cable from the power supply to the mating receptacle on the transformer enclosure. If additional filament transformers are to be installed, their primary power is obtained from the gun #1 enclosure. Connect the primary power to each enclosure with the jumper cables provided.

3.3.3 Gun X-Y Coil Connection

The Connection of the sweep generator to the x-y coils of the electron beam gun is made to a terminal board mounted to the exterior rear wall of the sweep generator (refer to figure 3-3). The wires connecting the horizontal and lateral coils of the gun should be brought out of the tank by way of the feedthroughs and connected to the appropriate terminals of TB1. These wires should be at least 18 gauge. The sweeper should then be connected to a source of 115 VAC power.



ITEM NO.	QTY	PART / IDENT NUMBER	DESCRIPTION	REMAR
			LIST OF MATERIALS	

	DRAWN	K.STANDRIDGE
	DESIGNER	
	CHECKED	
	APPROVED	
NEXT ASSEMBLY	RELEASED	
UNLESS OTHERWISE SPECIFIED	MATERIAL:	
SURFACE FINISH 123√	.X ±.1 .XX ±.01 .XXX±.005 FRAC±	ANGLES ± 1/2°	FINISH:	
DO NOT SCALE DRAWING		

thermionics laboratory, inc.
999 Beecher Street San Leandro, Ca. 94577

EBPS CONTROLLER/TRANSFORMER CONNECTION

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A | 3-2

Scale X | Sheet 1 OF

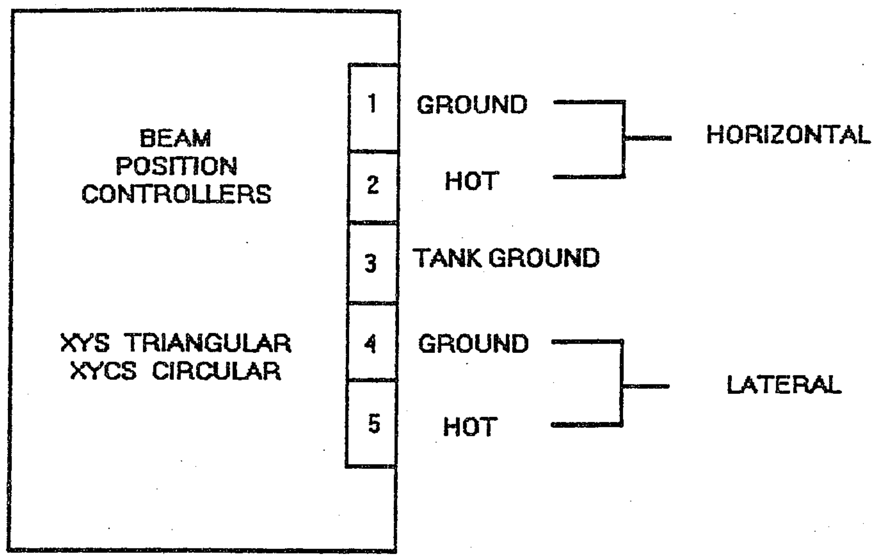


FIGURE 3-3
X-Y COIL
CONNECTION

3.3.4 Interlock Connections

The external interlocks are connected to the power supply through a terminal board, which is located on the rear panel of the high voltage control panel. These connections are also shown in figure 2-4 (page 2-14). Number 18 gauge or larger wire should be used. This section contains a description of these interlocks.

<u>WARNING</u>
ALL STATEMENTS REGARDING OPERATOR AND EQUIPMENT SAFETY ARE VOID IF THE EXTERNAL INTERLOCKS ARE NOT PROPERLY INSTALLED.

3.3.4.1 Vacuum Interlock

This interlock insures that there is sufficient vacuum within the tank before the power supply and gun can be energized. This point normally coincides with the energizing of the vacuum gauge filaments and most controllers have auxiliary contacts for this purpose. Their connection should be made to terminals 1 and 2 of TB901.

3.3.4.2 External Interlock

This interlock is provided for the insertion of additional high voltage interlocks that the user might require. These may include emergency off pushbuttons, crucible water interlocks, high voltage access interlocks, etc. The normally closed contacts of each interlock should be connected in series and terminated on terminals 3 and 4 of TB901.

3.3.4.3 Gun Water Interlocks

Install a water flow switch in the return of the cooling system for the electron beam gun. This switch should close when there is sufficient water flow in each gun and associated shields. Connect the switch to terminals 5 and 6 of TB901.

3.3.5 Rate Control

A negative (ref to ground) 0 to 10 volt signal will control the level of emission of the gun. This signal is normally generated by a rate controller. It should be connected to terminals 7 and 8 of TB901.

3.3.6 Additional Gun Controllers

Interlock and rate control signals are connected in an identical manner to the described in sections 3.3.5 and 3.3.6.

3.3.7 Primary Power

When the power supply control cables have beed installed, primary power should be connected. The primary cable provided for connection to the source of AC power. This cable should be connected to a user supplied disconnect. The required primary power for particular power supplies is listed in section 1 of this manual. The green wire of the cable should be connected to ground.

Section 4

Operation

4.1 Introduction

This section contains a description of the normal operations procedures for the EBPS 6/10/15/20 Power Supply.

4.2 Turn On

1. Place all of the circuit breakers located on the front panel of the power supply in the ON (top) position. Allow five minutes for the tetrode tube filaments to heat up.

2. All of the light emitting diodes (LED) should be energized. If any are not energized, the open interlock must located and closed. (Remember that this is sequential string and the first interlock with a de-energized LED must be closed before the condition of the interlock following it will be indicated).

3. Refer to the instruction book for the position/sweep controller being used. Adjust the position controls to that prescribed by the gun manufacturer.

4. Turn on the high voltage power supply by depressing the HV ON pushbutton. Increase the high voltage level by adjusting the HIGH VOLTAGE potentiometer. High voltage (as indicated by the voltmeter) will now be applied to the electron beam gun.

5. Turn the gun on by depressing to SOURCE ON pushbutton.

6. Slowly increase the BIAS ADJUST potentiometer (located on the rear wall of the control chassis) to the point of filament emission. This will manifest itself by a slight increase in emission current. Decrease this adjustment slightly below the point where emission occurs. Leave the potentiometer at this setting.

7. Increase the SOURCE EMISSION ADJUST pot to the required level.

8. The position of the beam in the crucible can be moved or swept by adjustment of the sweeper controls.

9. The system is now operational.

4.3 Turn Off

1. Reduce the EMISSION ADJUST potentiometer of each gun to zero. The indicated emission should go to zero. If it does not, the bias setting is too high and should be reduced.

2. Turn off the gun filament power supply by depressing the SOURCE OFF pushbuttons.

3. Turn off the high voltage by depressing the HV OFF pushbuttons.

4. Turn off E-Gun and Tetrode circuit breakers. Leave control and Main circuit breakers on for ten minutes to allow tetrode to cool.

5. Turn off the MAIN POWER circuit breaker.

6. Turn off the primary source of power to the system.

7. The system is now totally off.

Section 5

Maintenance

5.1 Introduction

The section contains a description of the procedures for troubleshooting the EBPS 6/10/15/20 Power Supply. Before attempting to troubleshoot any part of the system, section 2 of this instruction book should have been read and understood.

<u>*Caution*</u>

Lethal voltage is present within this equipment. Be sure that All power is removed prior to performing maintenance or Making measurements. Always discharge the component with a shorting rod before you make contact.

5.2 Required Equipment

Following is a list of equipment needed to perform the procedures described in the following sections:

1. Digital Multimeter
2. High Voltage Probe for item 1, (20KV max voltage)
3. Oscilloscope – Single Channel – Standard Probe
4. Regulated Power Supply – Dual Polarity – 0 to 20 volts – 0 to 2 amperes
5. PB Board extender, 22 pins

5.3 High Voltage Power Supply

This section describes the procedure for preparing the high voltage power supply for troubleshooting.

5.3.1 Preparation

1. Disconnect the AC power source.

2. Remove the top front and rear panels of the power supply cabinet.

3. Disconnect the secondary power leads from the high voltage contactor (CON 1). This is best accomplished by removing the mounting screws from the lower front panel and pulling the panel forward. The contactor connections can then be accessed through this opening. This is an important step because it insures that high voltage cannot be applied during test procedures.

4. Replace the lower front panel.

5. Remove the power supply cabinet top panel (the exhaust blower power leads must be disconnected).

6. Reaching into the tetrode chimney, disconnect the tetrode anode and feed the wire through the chimney wall.

7. Pull the chimney out through the top.

8. Remove the tetrode by grasping the anode handles firmly and lifting out with a slight rotational twist. Lift the tetrode out of the cabinet.

9. If screen bypass capacitors are used, visually check each.

10. Remove all fuses located in the PC card rack.

11. The power supply is now ready to commence troubleshooting.

5.3.2 Interlocks and High Voltage Control

This section contains a procedure for checking the interlock chain.

1. The interlock power for the EBPS 6/10/15/20 Power Supply is 24 VDC. The power supply is located in the PC card rack and can be reached from the top (across the output terminals).

2. Install the CONTROL fuse (2A) and turn on the main source of AC power. Turn on the MAIN and CONTROL breakers. Measure that the control voltage is approximately 24 volts (+/- 4 volts). The CONTROL LED located on the control located on the control panel should also be illuminated.

3. Pump the system down or jump terminals 1 and 2 on TB901. The VACUUM LED in both the high voltage and gun filament interlock strings should energize.

4. Turn off the CONTROL circuit breaker and install the AIR fuses (5A). Turn on the CONTROL breaker and observe that the tetrode blower is energized. When it comes to speed, the CAB AIR interlock LED should energize. If it does not:

   A. Check that the air switch is firmly plugged into its hole on the tetrode deck.

   B. Repeat the check after shorting the two wires connected to the switch. The LED should energize. If this is the case, replace the switch.

5. Place a jumper across terminals 3 and 4 of TB901. The EXTERNAL interlock LED should energize

6. Place the key switch in the MAN mode. The key and READY LED's should energize. The green LED in the HV OFF switch should also be illuminated.

7. Depress the HV ON pushbutton. Its red LED should energize and there should be an audible sound from the high voltage contactor, indicating that it has pulled in. No high voltage will be present because of step 5.3-3 above.

8. Depress the "HV OFF" pushbuttons or open an interlock and the contactor should open.

9. Turn on the gun water. At some minimum value of flow, the WATER and READY LED's located in the gun filament interlock should energize.

10. Depress the GUN ON pushbutton and listen for an audible click coming from the associated gun filament transformer enclosure. This indicates that the filament contactor is energized. Depress the GUN OFF pushbutton and again listen for an audible click coming from the transformer enclosure.

11. Completion of these tests confirms the correct operation of the high voltage and filament interlock strings.

5.3.3 +/- 15 VDC Power Supply

The +/- 15 VDC power supply PC board (or International Power Model AD-15 0.4) is the first card from the right. Troubleshooting procedures follow. Refer to International Power Specifications Sheet or drawings 193-100-952 and 193-100-992.

1. Pull the card from its socket and replace it with the board extender. Insert the board in the extender socket. The components of the board should now be accessible for troubleshooting.

2. Pull all of the remaining boards out of their sockets and leave them in position in the card rack.

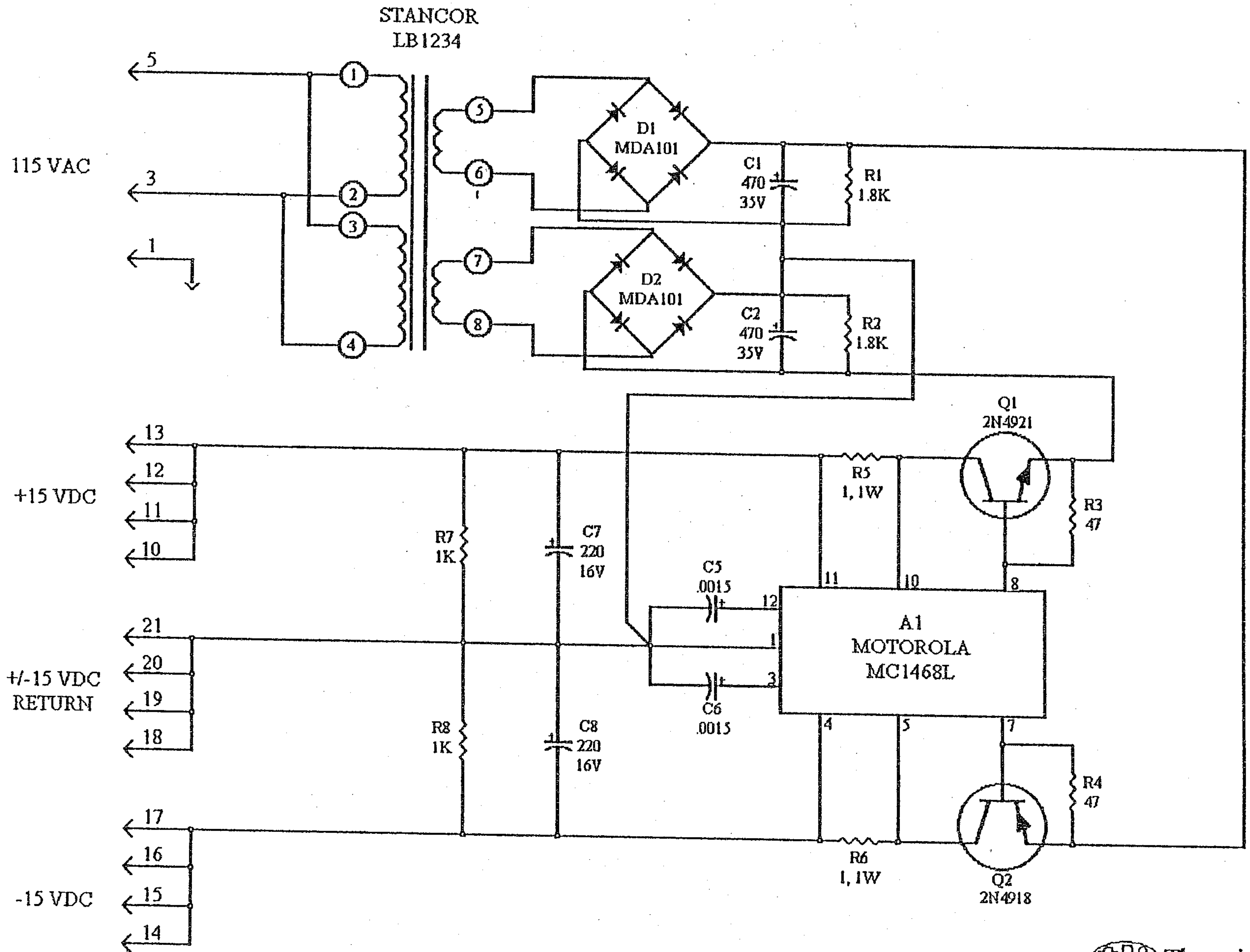
3. Place the probe on the positive side of C1. The voltage at this point should be approximately 30 VDC positive and the ripple should have a triangular shape. The magnitude of this ripple should be less the 100 millivolts peak to peak.

4. In a similar manner, check the negative side of C2. The CD voltage at this point should also be approximately 30 volts (negative) and the ripple should be the same as described in step 3.

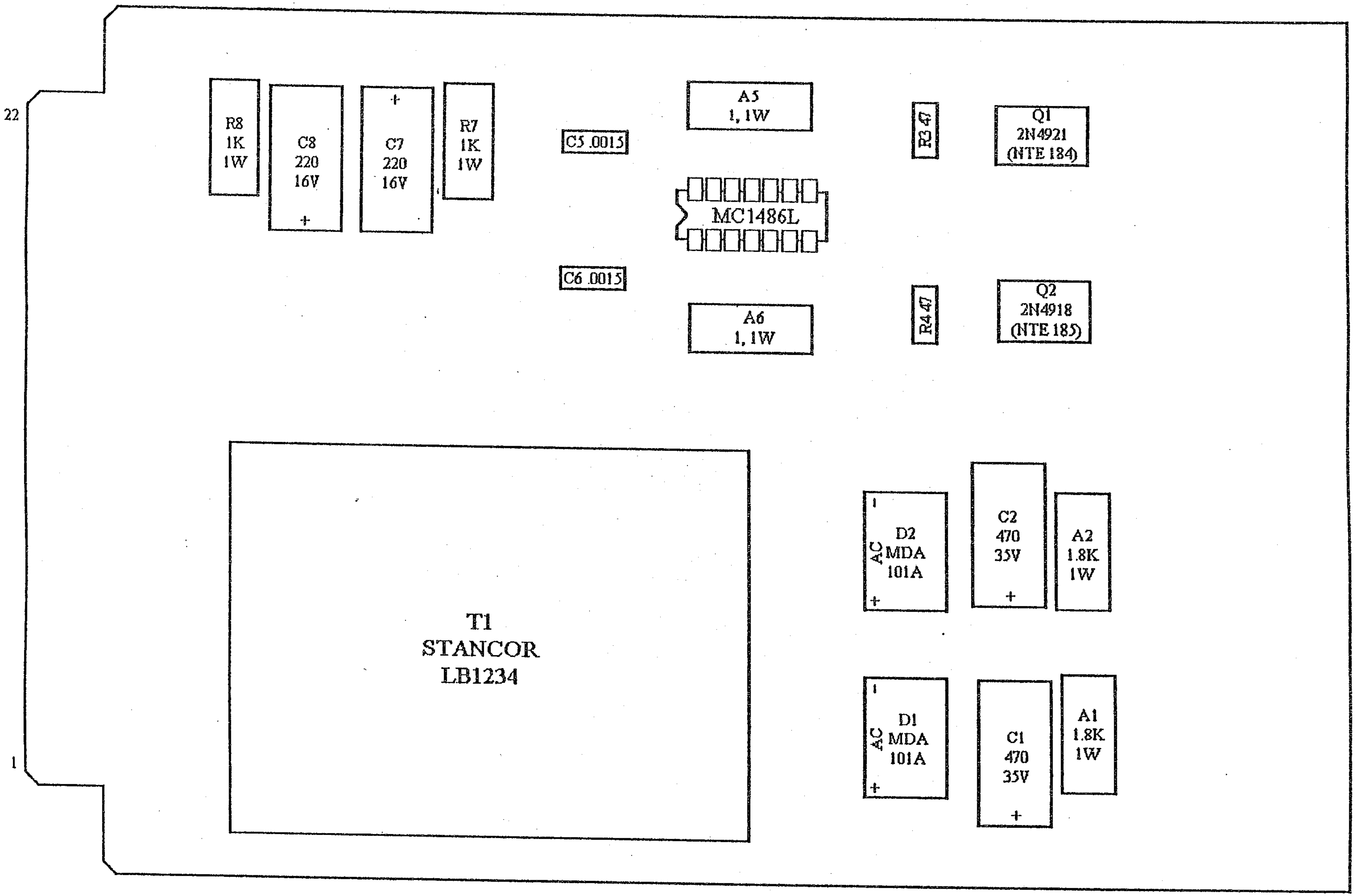
5. Place the probe on the positive side of C7. This voltage should be 15 volts positive and the ripple should be less than 10 millivolts peak to peak.

6. Place the probe on the negative side of C8. The voltage at this point should be –15 volts with a ripple less than 10 millivolts peak to peak.

If at any time during the troubleshooting procedures the measured voltage deviates greatly from the listed voltage, the problem must be isolated and repaired.



Thermionics Laboratory Inc.
15 VDC Power Supplt Schematic
Drawing #193-100-952



Thermionics Labratory Inc.
15 VDC Power Supply Layout
Drawing #193-100-992

5.3.4 Current Cutback Circuit

This section contains procedures for checking the current cutback circuit.

1. The current cutback PC board is the forth board from the right.

2. Pull the board out of its socket and install the card extender in its place. Insert the board in the extender. This should allow access to all components mounted on the board. Refer to drawings 193-100-752 and 193-100-782.

3. This board is checked by passing current through the associated shunt resistors and observing the circuit operation. Each channel is checked in an identical manner. The shunt resistor for the high voltage power supply is located on the left side of the tetrode deck. It is a gold 2-ohm resistor, and is mounted directly to the deck. Connect the positive side of the test power supply (see section 5.2) to the center tap of the tetrode filament transformer (T2). The negative supply should be connected to ground. Current form the test power supply will simulate output current from the high voltage power supply.

4. Turn on the MAIN and CONTROL circuit breakers. The ARC LED should be off.

5. Slowly increase the test current. At approximately (.9 amperes for the 6KW, 1.2 amperes for the 10KW, and 1.7 amperes for the 15KW) test current, the ARC LED should energize. If it does not energize when the test current is raised to 2 amperes continue with step 6. If the light turns on, proceed with step 7.

6. Place the scope probe on pin 7 of U1 (ref ground). Slowly increase the test supply current and observe that the voltage at pin 7 swings from approximately +12 volts to zero when the test current is approximately 1.7 amperes. The point at which the output switches can be changed by adjusting of the EMISSION potentiometer located on the PC card rack. Clockwise rotation of the potentiometer will increase the point at which the output of U1 switches. If the switching action does not occur, replace U1.

7. Place the probe on pin 15 of U7. The same switching action described above should be observed. If no, replace U7.

8. Place the probe on pin 1 of U4. This signal should switch from high to low when the test current is above setpoint. The negative swing of this signal triggers the multivibrator (U4). Replace U3 if the switching action does not take place.

9. Place the probe on pin 13 of U4 and repeat the test. When the test current is below setpoint, the output signal should be zero. Above setpoint, the out of U4

swings from zero to approximately 5 volts positive and will remain at the level for approximately 50 milliseconds. It will then drop to zero for a short period (approximately 20 milliseconds). The cycle is the repeated and will continue as long as the test current is above setpoint.

10. Place the probe on pin 11 of U3. The signal at this point will swing from low to high when the first multiplier triggers and will remain at this level until the end of the pulse. It will then swing to zero for the duration of the second multipliers pulse (10 microseconds). If the test current is still above setpoint, the cycle will repeat.

11. Place the probe on pin 16 of U5. This signal will be +15 volts when the test current is below setpoint and zero at setpoint. Short reset pulses coinciding with the output of the second multivibrator will also be seen. The LED mounted on the board and also the one mounted of the front panel will energize when U5 switches.

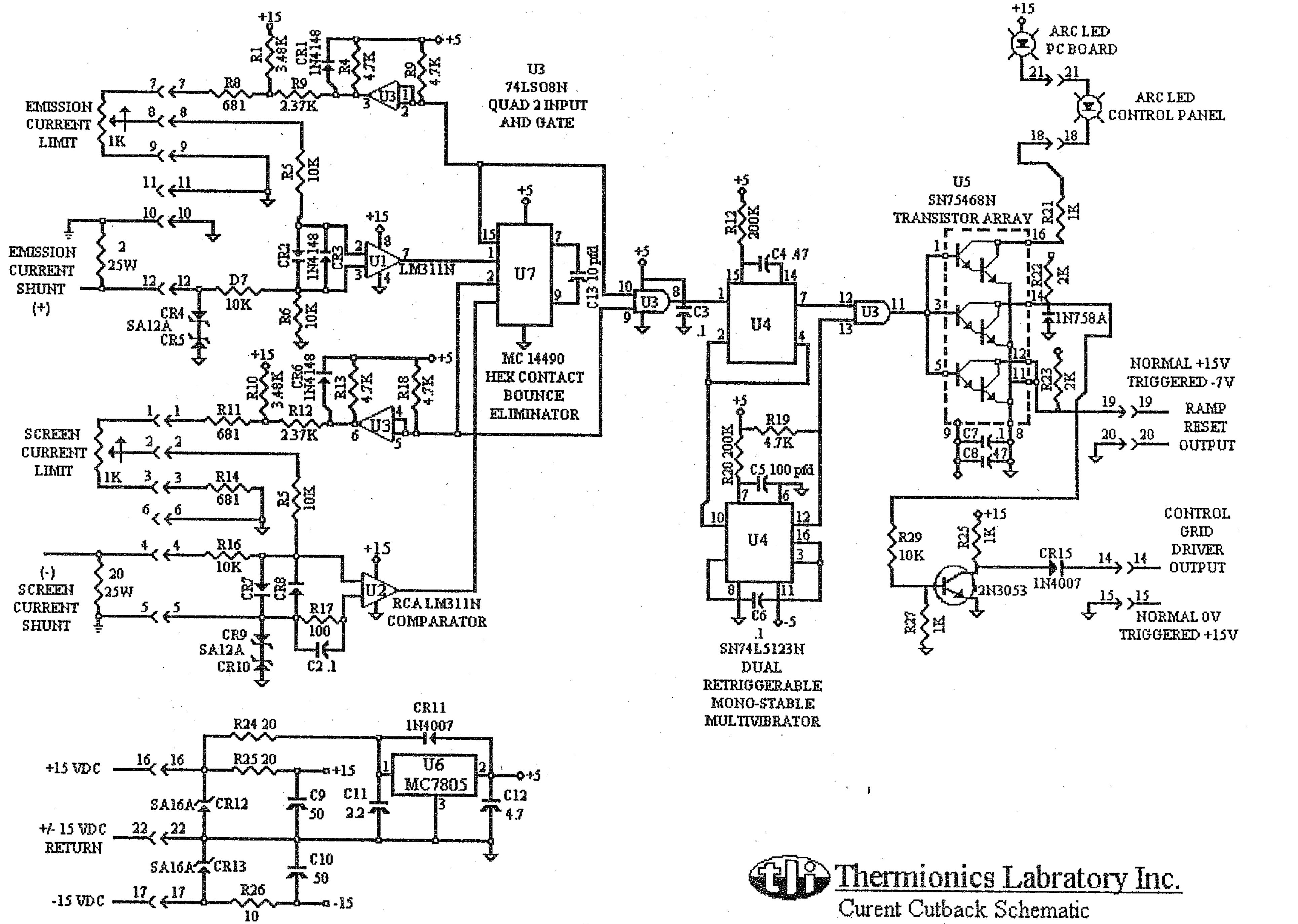
12. Place the probe on pin 14 of U5. This signal should be +5 volts below setpoint and zero above. The reset pulses should also be observed.

13. Place the probe on the anode of CR15. The signal should be near zero when the test current is below setpoint and +12 volts when the current exceeds setpoint.

14. Place the probe on pin 12 of U5. This point provides the arming signal for the ramp generator. It should be approximately 12 volts positive below setpoint and zero above setpoint.

15. The second channel of the current cutback circuit triggers when the tetrode screen current is greater that a preset limit. It receives its signal from the screen power supply return shunt resistor. This resistor is included in the power supply assembly, which is mounted on the tetrode deck. When viewed from the front of the cabinet, this assembly is located under the card cage behind the front panel. Locate the gold 2-ohm screen shut resistor on the left side directly behind the front panel. The negative side has a Violet wire and the ground side have a Green wire. Place the negative from the test supply on the negative (cathode) output of the bridge rectifier and connect the positive lead to ground. Turn on the MAIN and CONTROL circuit breakers and slowly increase the output of the test power supply. The arc light should energize at a test current of approximately 500 milliamperes. If it does not, replace U2.

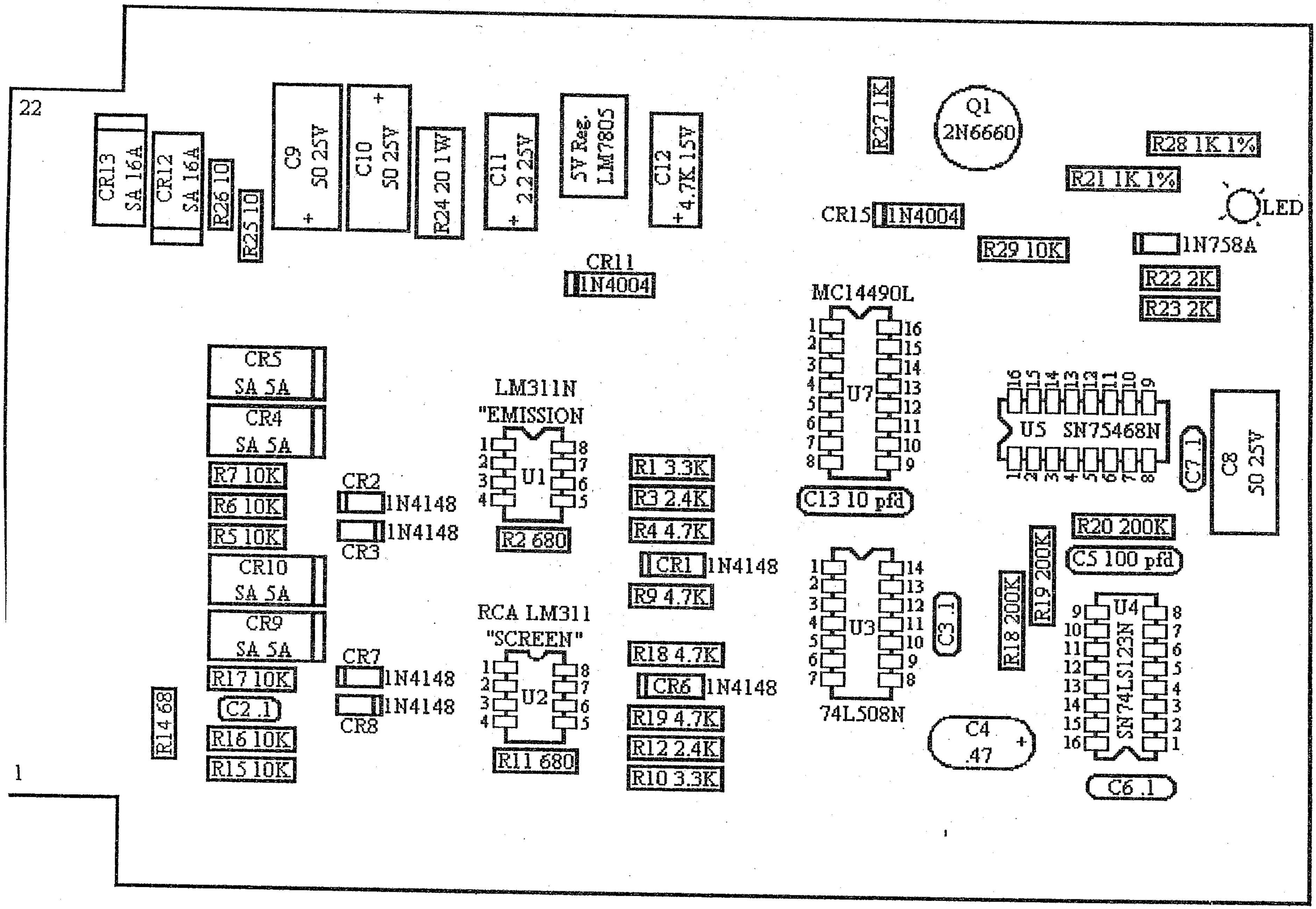
16. Remove the card extender and insert the current cutback board in its socket.



Thermionics Labratory Inc.

Curent Cutback Schematic

Drawing #193-100-602



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Current Cutback Component Layout

Drawing #193-100-782

5.3.5 Ramp Generator

This section describes a troubleshooting procedure for the ramp generator. Refer to drawing 193-100-702.

1. The ramp generator is the second PC board from the right. Place the extender card in this position and insert the ramp generator in the extended socket.

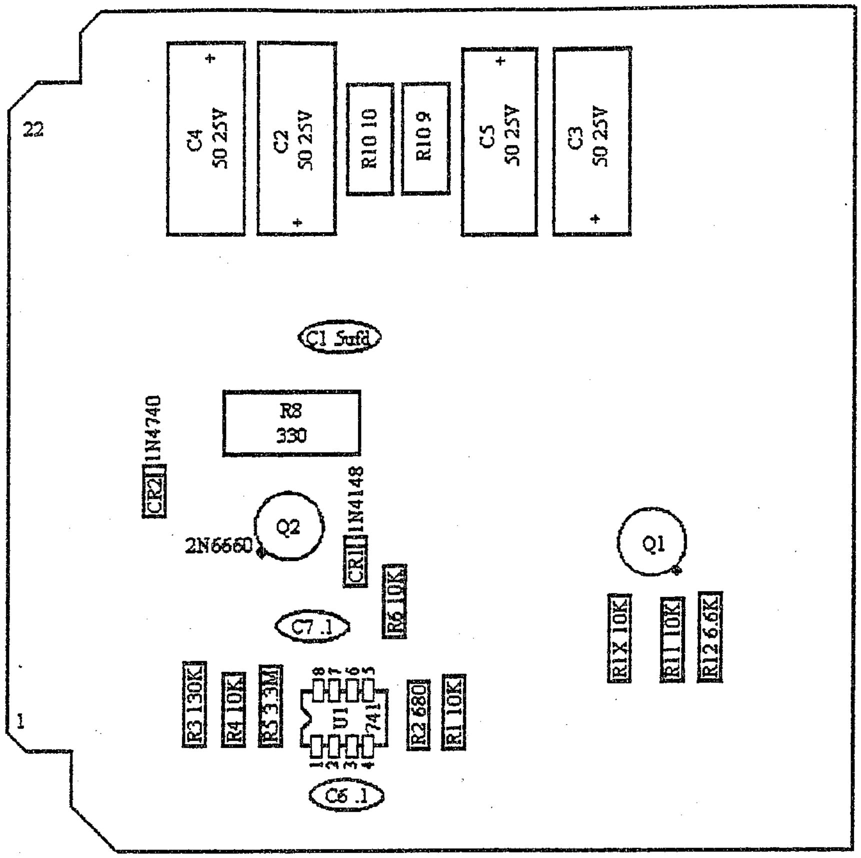
2. Place the scope probe on the cathode side of CR2 (pin 19 of the board). This signal should normally be approximately 10 volts and zero when the current cutback is tripped. If it is not proceed with the following steps.

3. Place the probe on the cathode side of CR2 (pin 19 of the board). This signal should be zero under normal conditions and +13.5 volts when the test current is above setpoint. If this signal in not present, replace Q1.

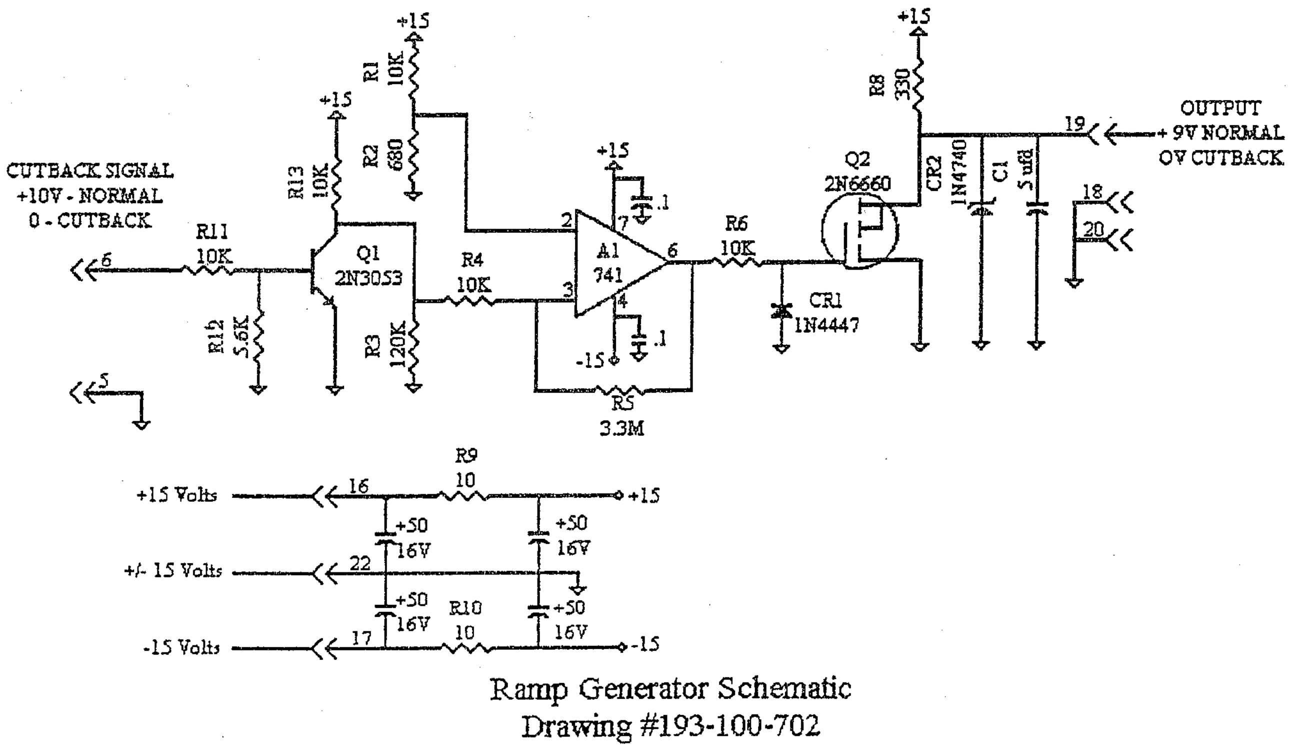
4. Place the probe on pin 6 of A1. This should be –13 volts under normal conditions and +14 volts above setpoint. If it is not, replace A1.

5. If the signal described in step 4 is present but there is no output on pin 19 of the board, replace Q2.

This completes the checkout of the ramp generator PC board



Ramp Generator Board Layout
Drawing #193-100-732



Ramp Generator Schematic
Drawing #193-100-702

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5.3.6 Regulator PC Board

This section describes the troubleshooting procedures for the regulator PC board. Refer to drawings 193-100-852 and 193-100-882. This PC board is the third board from the right located in the card cage of the EBPS power supply.

At this point the output of the HV contactor should be disconnected such that no AC voltage can be applied to the input of the High Voltage Transformer.

Remove the PC board and install the extender card in its place. The PC board can now be installed in the extender card.

1. Place a 10K ohm resistor is series with the negative output of the test power supply. Connect a multimeter across the 10K-ohm resistor and the output of the resistor to pin 8 of the PC board or the input of R2. Adjust the test power supply so that the voltage across the 10K ohm resistor is negative 5 VDC (displayed on the multimeter). This test input simulates the output of the HV voltage divider when the EBPS power supply is turned up to it's maximum output (10KV). Adjust the test input to zero VDC (zero VDC across the 10KV ohm resistor).

2. Turn on the MAIN and CONTROL circuit breakers. Place the scope probe on pin 6 of U1 (reference ground). Slowly increase the test input to 5 VDC. The voltage at pin 6 of U1 should increase from zero to 4.5 – 5 VDC. Reset the test input to zero.

3. Place the scope probe on pin 6 of U4 and repeat step 2. This voltage should be zero and swing to negative 10.7 VDC.

4. Move the scope probe to pin 11 of the PC board (anode of CR7). Repeat step 3, the results should be the same. The output of pin 11 is the input to the voltmeter on the Gun 1 control panel. The voltmeter should now be read nearly 10KV. Reset the test input to zero VDC.

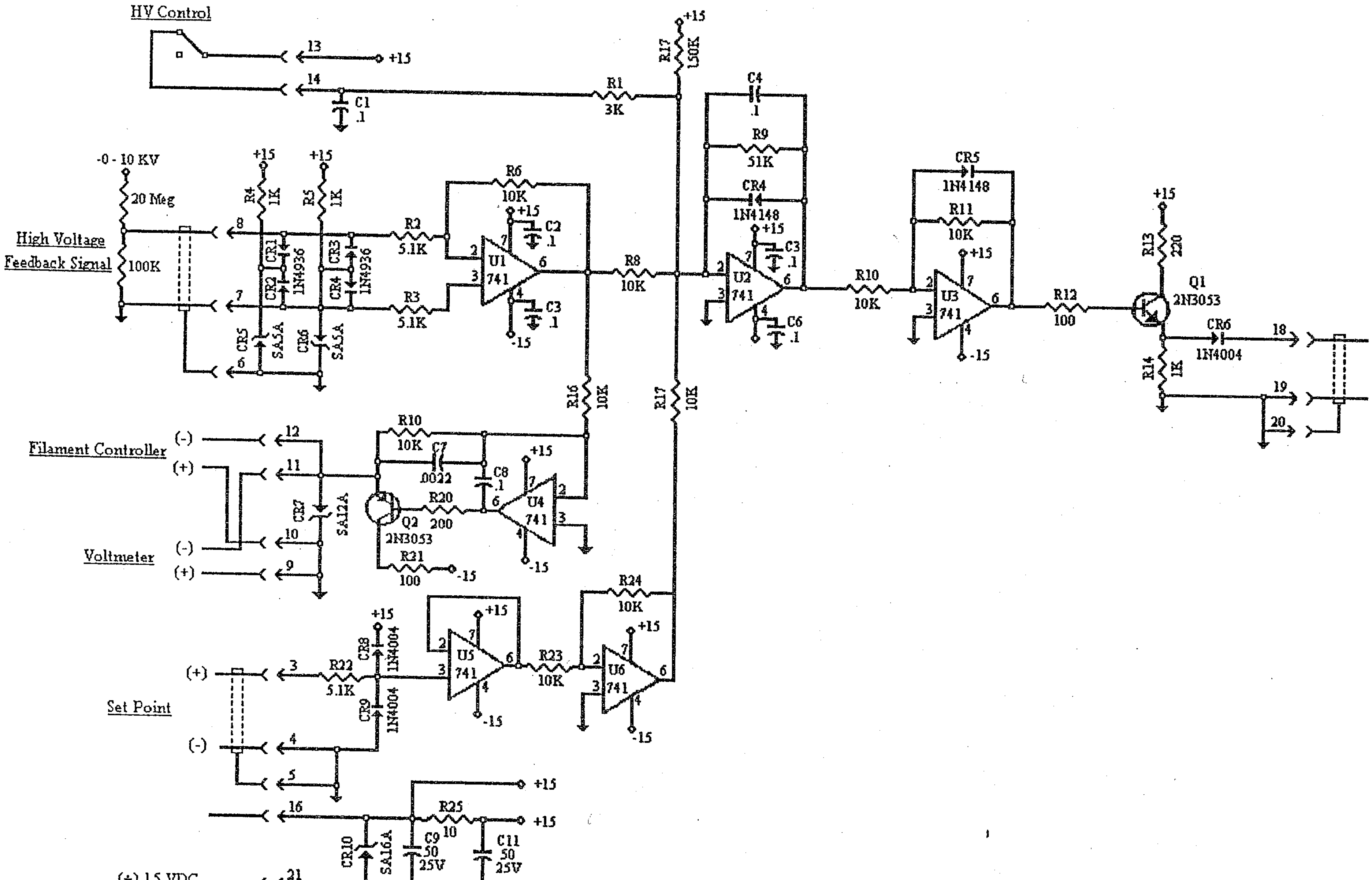
5. Connect the scope probe on pin 6 of U2. Turn the VOLTAGE ADJUST potentiometer to it's full counter-clockwise position. With the test input at zero VDC, the voltage at pin 6 of U2 should be approximately negative 12.8 VDC. Close the interlock string, turn the keyswitch to MANUAL and depress the HV ON pushbutton. The voltage at pin 6 of U2 should swing to approximately negative 5 volts. Slowly turn the VOLTAGE ADJUST potentiometer clockwise, the voltage should swing very close to zero VDC. Slowly increase the test input. The voltage at pin 6 of U2 will swing rapidly to negative VDC.

6. Connect the scope probe to pin 6 of U3. Turn the VOLTAGE ADJUST potentiometer to it's full counter-clockwise position. With the test input at zero VDC, the voltage at pin 6 of U3 should be approximately positive 12.8 VDC. Close the interlock string, turn the keyswitch to MANUAL and

depress the HV ON pushbutton. The voltage at pin 6 of U3 should swing very close to 5 VDC. Slowly turn the VOLTAGE ADJUST potentiometer clockwise, the voltage should swing very close to zero VDC. Slowly increase the test input, the voltage at pin 6 of U3 will swing rapidly to positive 12.8 VDC.

7. Connect the scope probe on the emitter of Q1. Turn the VOLTAGE ADJUST potentiometer to it's full counter-clockwise position. With the test input at zero VDC, the voltage on the emitter of Q1 should be approximately positive 12.2 VDC. Close the interlock string, turn the keyswitch to MANUAL and depress the HV ON pushbutton. The voltage on the emitter of Q1 should swing to approximately positive 4.4 VDC. Slowly turn the VOLTAGE ADJUST potentiometer clockwise, the voltage should swing very close to zero VDC. Slowly increase the test input, the voltage on the emitter of Q1 will swing rapidly to positive 12.2 VDC.

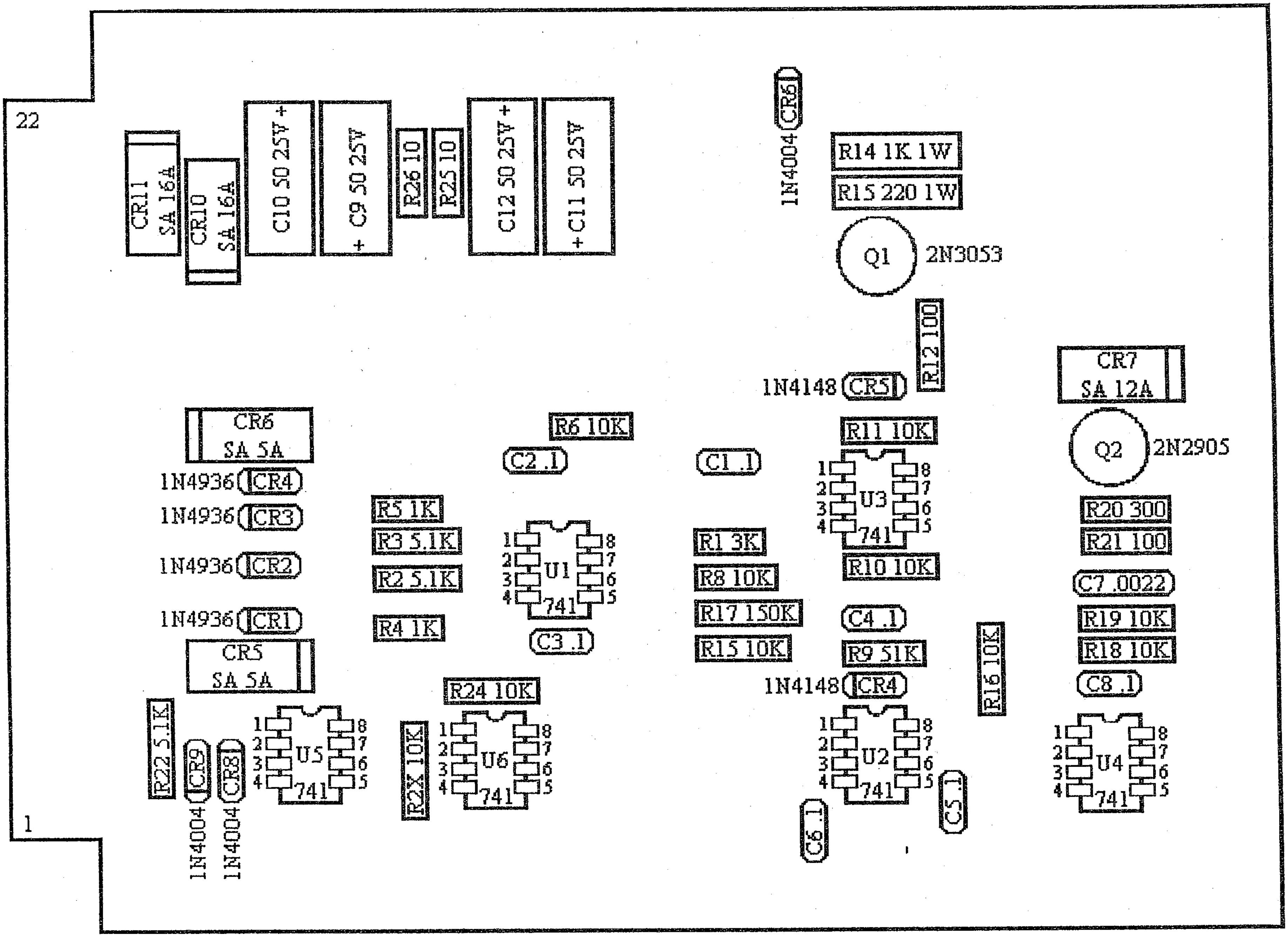
This completes the test of the Regulator PC board. Turn off all circuit breakers, remove the extender card and place the PC board back into its position.



Thermionics Laboratory Inc.

Regulator Amplifier

Drawing #193-100-852



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Regulator Amplifier Componet Layout

Drawing #193-100-882

5.3.7 Screen Power Supply

The section contains a description of the procedure for checking the screen power supply.

1. Place one lead of the multimeter on the topmost ting of the tetrode socket. Connect the second lead to ground. The meter must be capable of reading 1000 volts maximum.

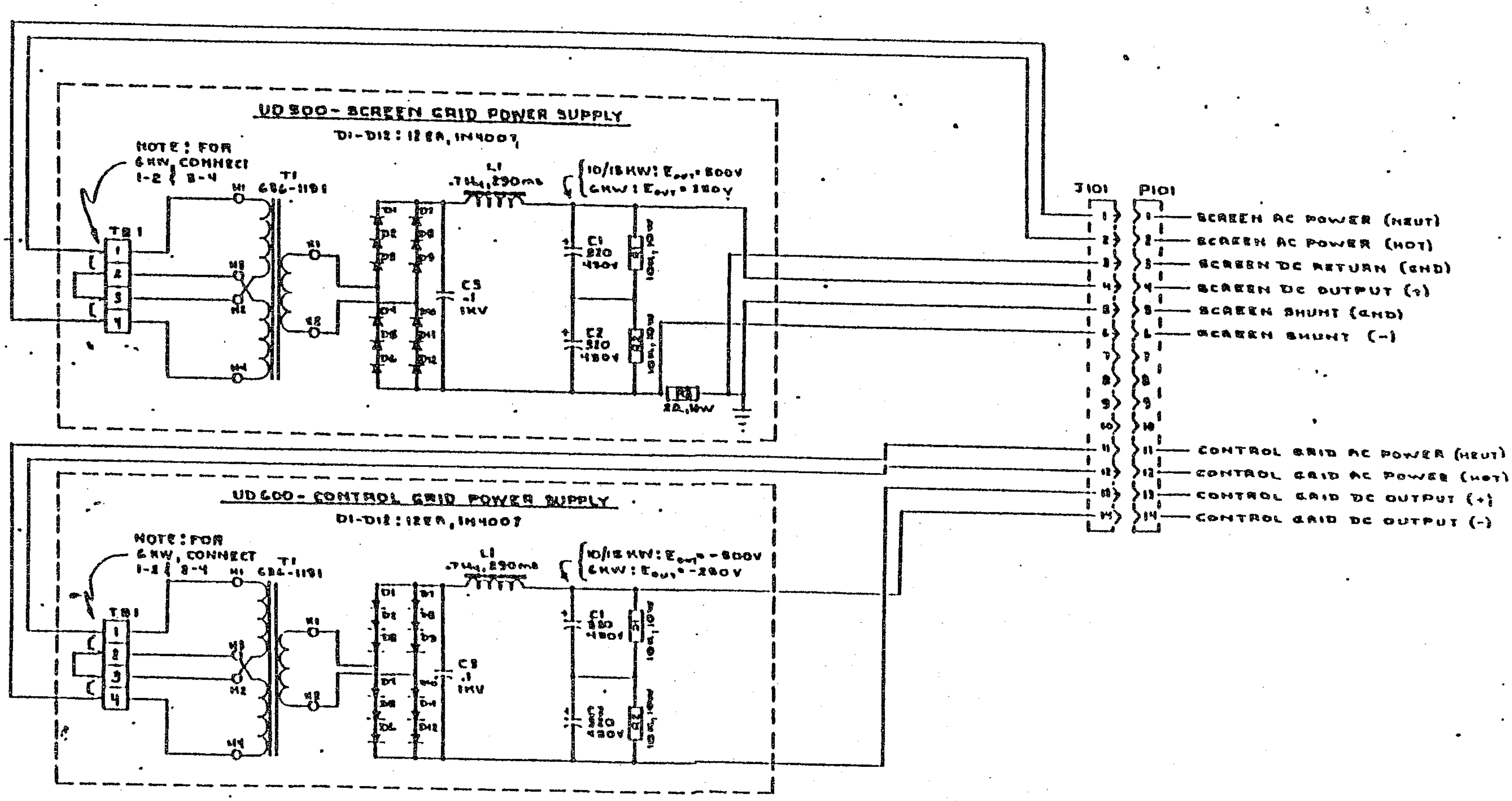
Caution

This step requires measurement of voltages is excess of 500 volts.
Use care when performing these tests.

2. Install the SCREEN fuse.

3. Turn on the MAIN and CONTROL circuit breakers. Observe that the meter swings to approximately +500 volts. If it does not, the screen power supply must be checked. Its schematic is shown in drawing 193-100-023.

4. When the screen supply is operating normally, turn off the circuit breakers and remove the screen fuse.



EB Technology

SCALE:	APPROVED BY:	DRAWN BY
DATE:		REVISED

WIRING DIAGRAM, SCREEN/CG POWER SUPPLIES

DRAWING NUMBER
193-999-0?

5.3.8 Control Grid Power Supply and Control Grid Driver

This section contains a description of the steps required to troubleshoot the tetrode control grid circuit.

Step 1

1. The control grid driver is contained on the PC board located in the furthest left socket. The board is located behind an insulated protective barrier. Install the extender board and insert the PC board in its socket.

Caution
This step requires measurement of voltages is excess of 500 volts.
Use care when performing these tests.

2. The schematic for the control grid driver is shown in drawing 193-100-802. Place the multimeter across C1. Install the CONTROL GRID fuse and turn on the MAIN and CONTROL GRID circuit breakers. The voltage across C1 should be approximately 500 volts DC. If it is not, the defective component in the control grid power supply must be located and replaced. The schematic for this power supply is shown in drawing 193-100-023. Turn off the CONTROL circuit breaker and move the multimeter lead that is on the pin 1 side of C1 to ground. Turn on the circuit breaker and observe that the voltage indicated be the multimeter is approximately 450 volts.

3. Place the VOLTAGE LEVEL ADJUST potentiometer in its fully counter-clockwise position. Close the high voltage interlock string and depress the HV ON pushbutton. The multimeter should indicate approximately 250 volts. Now slowly turn the VOLTAGE LEVEL ADJUST potentiometer clockwise. The indicated voltage should drop to nearly zero. This checks the operation of the control grid driver PC card.

4. Turn off the MAIN and CONTROL circuit breakers. Remove the card extender and replace the control grid driver PC board in its socket. Replace the insulated barrier in front of the card.

5. Place the negative lead of the multimeter on the socket ring that is second from the top. Connect the positive side of the meter to ground. Repeat step 3.

Step 2

At this point the out of the HV contactor should be disconnected such that no AC voltage can be applied to the input of the High Voltage Transformer.

1. Locate the 2-ohm Emission Shunt Resistor and connect the positive side of the test power supply to the center tap of the tetrode filament transformer. The negative side should be connected to ground. Refer to the section #5.3.4 current cutback circuit.

2. Connect a multimeter across C1. Remove pin 1 side of C1 and connect it to the control grid socket on the TETRODE TUBE SOCKET, 2nd ring from the top.

3. Install 5A Control Grid fuse. Remove 5A Screen Grid fuse.

4. Turn on the MAIN and CONTROL circuit breakers. Depress the HV ON pushbutton. Slowly turn up the VOLTAGE ADJUST potentiometer clockwise until indicated voltage drops to nearly zero.

5. Adjust test power supply current to trip cutback circuit. Verify trip level is set correctly.

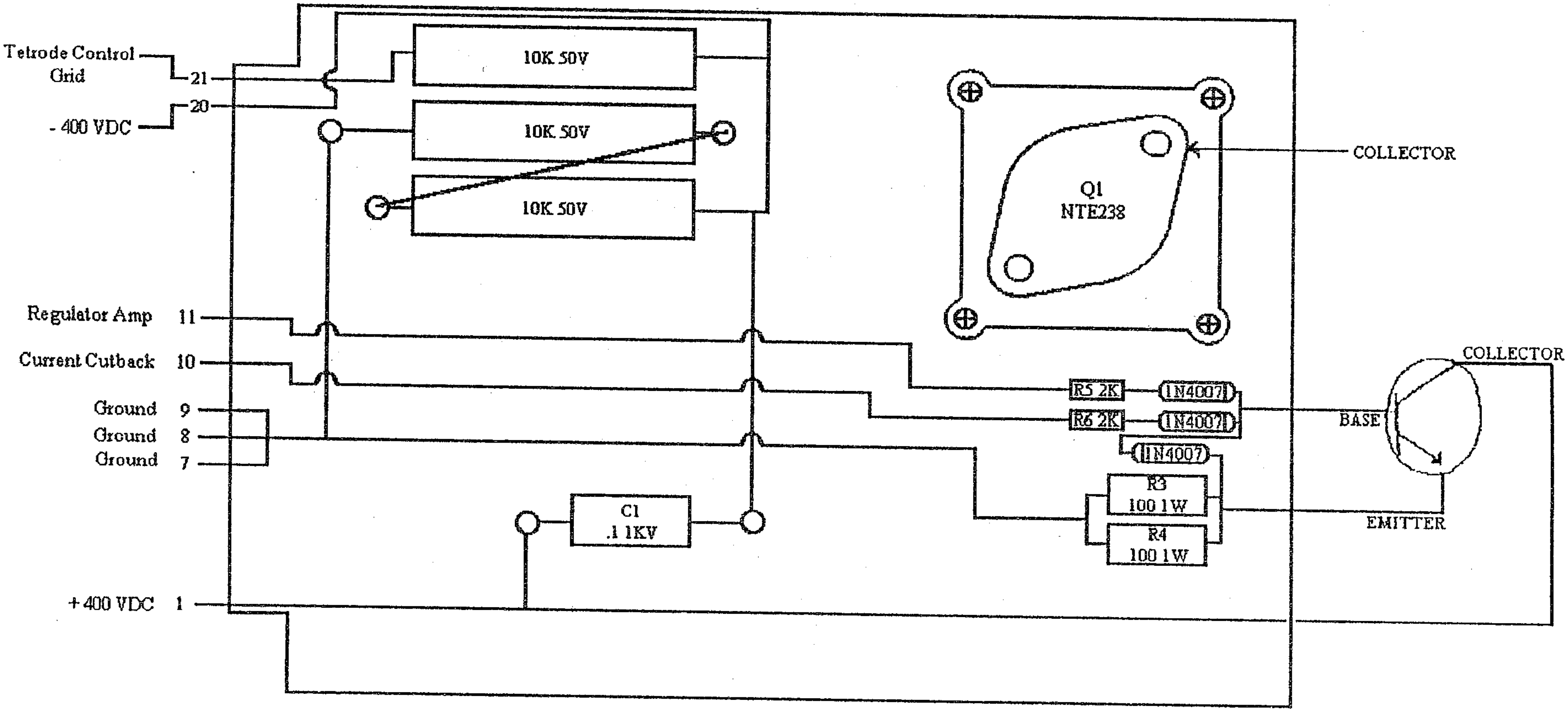
6KW	= .9 amperes
10KW	= 1.2 amperes
15KW	= 1.7 amperes

Control Grid Voltage should rise to the power supply voltage.

6KW	= Neg. 280 VDC
10KW	= Neg. 588 VDC
15KW	= Neg. 588 VDC

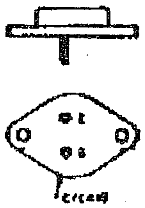
Set the power supply back to zero. Turn the VOLTAGE ADJUST potentiometer counter-clockwise to zero and then depress HV pushbutton off. Turn MAIN and CONTROL circuit breakers off.

6. The screen grid fuse should still be removed. Locate the 2-ohm Screen Grid Shunt Resistor. Connect the negative from the test power supply to the negative (cathode) output of the Screen Grid Supply and the positive lead to ground. Repeat steps above to test Screen Grid Cutback circuit. Circuit should be adjusted to trip at .4 amperes for the 6KW, 10KW, and 15KW power supplies. Refer to section 5.3.4 #7 Tetrode Screen Current Setup.



NTE238

T-NPN, Si, TV Horiz Output

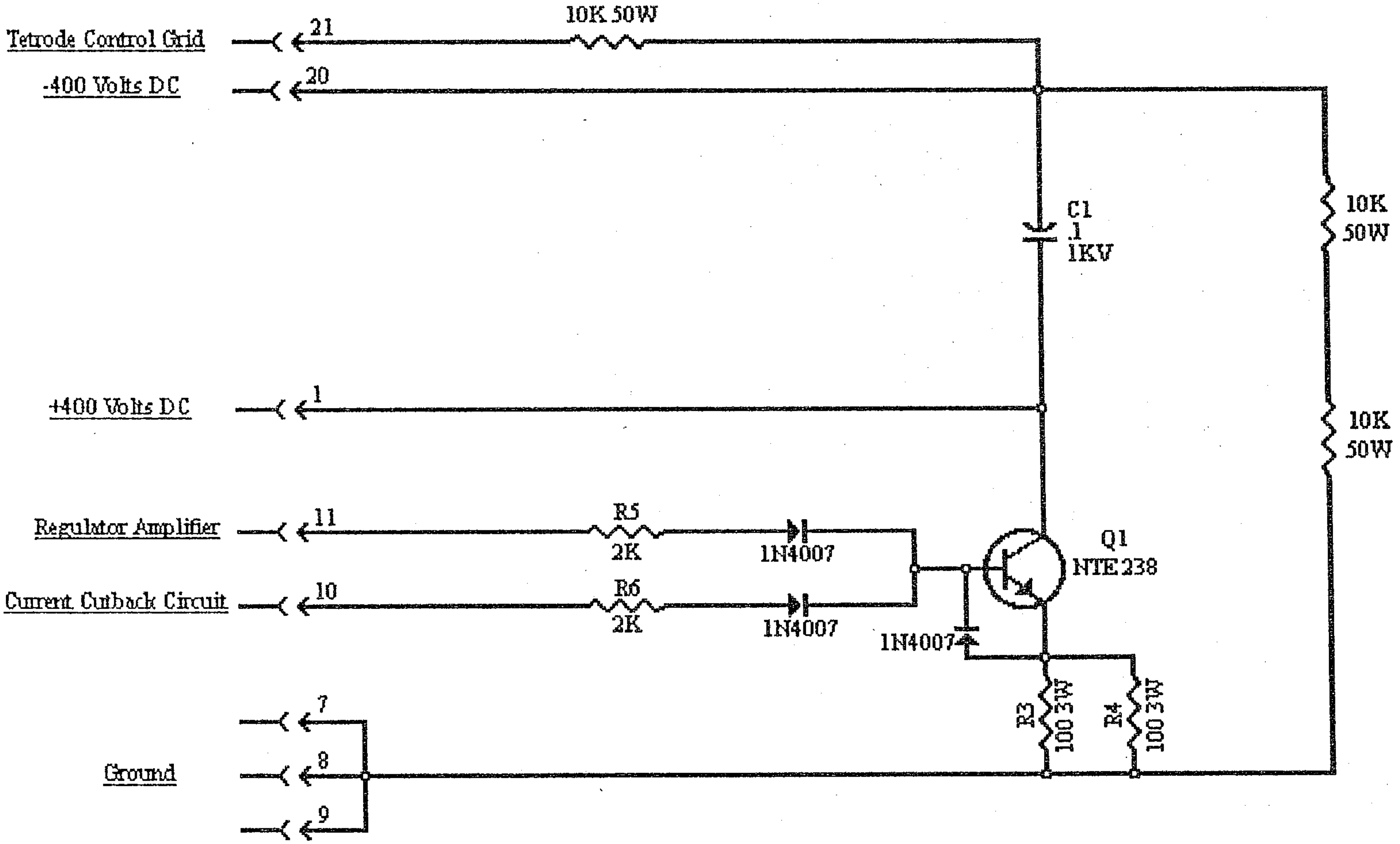


V_{CBO} - 1500V
V_{CER} - 1500V
V_{EBO} - 5V

I_C - 8A
P_D - 100W
h_{FE} - 20 Typ

TO-3
Replaces: ECG238, SK3710

Thermionics Laboratory Inc.
Control Grid Driver Componet Layout
Drawing #193-100-802



Thermionics Labratory Inc.

Control Grid Driver Schematic

Drawing #193-100-902

5.3.9 Preparation for High Voltage Checkout

This section describes the necessary steps to close the power supply and check its operation. It is assumed the power supplies condition is as it was left after completing the procedures described above.

1. Turn off the source primary power.

2. Connect the lead that is normally connected to the tetrode anode to cabinet ground. (IMPORTANT!)

3. Disconnect all output leads that are connected to the output stud and push these wires away from the high voltage components. It is preferred that these wires be grounded. This step insures that the output of the power supply is open.

4. Mount all rear panels.

5. Set the cabinet top in place.

6. Remove the mounting screws from the lower front panel and pull it forward. Connect the power leads to the high voltage contactor (these were removed in step 5.3-3). Replace the lower front panel.

7. Mount the cabinet sides. Except for the panel covering the PC card rack, the power supply should be completely enclosed and ready for high voltage tests.

5.3.10 High Voltage Checkout – No Tetrode

1. This test will check the operation of the high voltage power supply. Be sure that it has been prepared according to section 5.3.9, above. All cards are installed, the primary contactor is connected and (IMPORTANT) the output high voltage cables have been disconnected.

2. Install all fuses located on the PC rack.

3. Apply primary power and turn on the MAIN and CONTROL circuit breakers.

4. Complete the high voltage interlock string and place the MODE selector switch in the MANUAL position.

5. Depress the HIGH VOLTAGE ON pushbutton. The output voltmeter should go full scale (greater than 10KV). If this is observed, depress the HIGH VOLTAGE OFF pushbutton and observe that the voltage goes to zero.

Confirmation of these tests assures that the high voltage rectifier is operating properly and you may proceed with the next step.

5.3.11 High Voltage Checkout -- With Tetrode

This section provides the test procedure for checking the operation of the high voltage supply with the tetrode installed.

1. Disconnect the primary source of power.

2. Remove the cabinet top.

3. Install the tetrode by grasping it by the anode handles provided and firmly inserting it in its socket. When installed, it should fit tightly and resist turning.

4. Install the air chimney. Pass the anode lead through the hole provided and connect it to the tetrode anode cap with the hose clamp provided.

5. Connect the exhaust blower and install the cabinet top.

6. Check that there is no connection to the high voltage output terminal and apply power.

7. Check that the VOLTAGE ADJUST potentiometer is fully counter-clockwise.

8. Turn on the MAIN, CONTROL and TETRODE circuit breakers. Allow the tetrode approximately 2 minutes to heat.

9. Close the interlock string and depress and HIGH VOLTAGE ON pushbutton. The power will come on but these should be no output voltage indicated.

10. Slowly turn the VOLTADE ADJUST potentiometer clockwise. The output voltage should increase and be adjustable to 10 kilovolts output.

11. Depress the HIGH VOLTAGE OFF pushbutton and return the potentiometer to its fully counter-clockwise position.

This completes the checkout of the high voltage power supply.

5.4 Filament Control Circuit

This section describes the procedures for checking out the electron beam gun filament control circuit. The same equipment will be required as specified in section 5.2.

Caution

Lethal voltage is present within this equipment. Be sure that all power is removed prior to performing maintenance or making measurements. Always discharge the component with a shorting rod before you make contact.

5.4.1 Preparation

This section describes the steps that must be taken prior to proceeding with the checkout.

1. Remove the primary source of AC power.

2. Remove the air filter assembly from the rear of the power supply and remove the high voltage output lead (or leads) from its insulated stud (IMPORTANT). Connect the removed leads to ground. In this configuration, the power supply is open circuited and can be turned on without applying high voltage to the external circuits.

3. Replace the air filter.

4. Remove the cover from the filament transformer enclosure. This is accomplished by removing the screws from the bottom and pulling the base plate out of the enclosure.

5. Remove the control chassis from its rack mounting and remove its top.

In summary, the high voltage leads have been removed from the power supply, the filament transformer and associated electronics are accessible and the top has been removed from the control chassis.

5.4.2 Interlocks and Control

This section provides a procedure for checking the operation of the filament interlock string and ON – OFF controls.

1. Apply primary power.

2. Turn on the MAIN and CONTROL circuit breakers.

3. Either pump the vacuum chamber or short terminals 1 and 2 of TB901. The VACUUM LED (LT911) should now be energized.

4. Either turn on the gun cooling water or short terminals 5 and 6 of TB901. This will light the WATER LED (LT912). The READY LED (LT912) will also be energized.

4. Check that the SOURCE circuit breaker is off. Depress the GUN ON circuit breaker and observe that the gun contactor on the filament transformer assembly pulls in. Depress the GUN OFF pushbutton and observe that the contactor is de-energized. This completes the checkout of the electron gun filament ON – OFF circuit.

Filament Check:

The filament check circuit is provided to check the operation and / or condition of the e-gun filament and associated control circuits without high voltage. A momentary rocket switch (S904) and an indicator LED (LT909) are located on the control panel labeled Filament Check. The 24vdc to energize the filament check relay (K904) is applied to S904 after the key switch is in Auto or Manual position and the vacuum and water interlocks are closed. TB901 – 2 is wired to the filament check rocker switch. When the filament check switch is depressed the filament check relay (K904) and the filament control relay are energized. The bias circuit is switched to its maximum setting which provides a safe DC control voltage to check the gun filament. The "Gun On" circuit is energized which closes the contactor in the filament transformer enclosure providing primary power (240vac) to the filament transformer. The emission metering circuit is changed to monitor the primary current of the filament transformer. The filament transformer primary is controlled by a 10amp SCR controller. When the pre-set bias DC voltage signal is applied to the SCR controller, the phase–controlled power out of the controller is applied to the primary of the filament transformer. A current transformer transducer provides a signal to the emission meter to read primary filament transformer current. A reading of 5 AC volts is an indication that the filament transformer AC secondary voltage is working.

An upscale reading will indicate current is passing through the filament. A reading of .25 (25 amps) is a normal current reading when the filament check circuit is activated. When the Filament check switch is turned off the gun on – off control will return to a ready state gun – off position. Be sure the emission adjust potentiometer is turned fully counter clockwise to a zero start position before turning on the gun filament circuit. The gun filament circuit is now interlocked with the high voltage power supply and all associated circuits are returned to their normal functions.

If no upscale reading is indicated check the condition of the filament. To check the AC voltage of the filament transformer turn the high voltage power supply to a safe or off condition before connecting an AC volt meter, unplug the dual HV connector and using a grounded high voltage grounding hook be sure the filaments conductors are properly discharged of high voltage. Connect the two AC voltmeter leads across the dual high voltage connector high current sockets inside the Delron insulator. When the filament check switch is depressed, an AC voltage will be applied across the two connectors.

5.4.3 Transductor Circuit

The transductor and associated amplifier is located in the filament transformer assembly. Refer to drawings 192-017-073 and 192-999-982.

1. The center conductor of the high voltage lead passes through the transductor and is connected to the center-tap of the filament transformer. Pass a lead through the transductor along with the high voltage lead so that a test current can pass through the transductor.

2. Connect the test power supply to the wire passing through the transductor. The positive lead should be connected to the transformer side and the negative lead should be connected to the side nearest the panel.

3. The transductor provides a DC signal that is proportional to the current passing through the transductor. There are only two active components associated with the amplifier (Q1 and Q2) and the circuit is checked by passing a current through the transductor while observing the amplifier output. If there is a failure, it can usually be repaired by replacing the two transistors.

4. Place the scope probe on the emitter of Q2. Slowly raise the output of the test power supply, the signal should rise to approximately +5 volts with one ampere passing through the transductor. If it does not, and before changing the transistors, check that the test power supply is connected properly (see section 5.4.3-2). The transductor amplifier provides a signal for the monitor circuit as well as providing a feedback signal for the emission regulator.

5. Repeat step 4 while observing the EMISSION current meter. With no test current, the meter should read zero. If it does not, the ZERO trimpot mounted on the transductor amplifier PC board must be adjusted. It can be accessed through a hole in the vertical panel. Adjust this pot to make the meter read zero.

6. Raise the test current to 1 ampere. Check that the meter reads 1 ampere. If it does not, adjust the trimpot mounted to the meter.

This completes the checkout of the transductor amplifier.

5.4.4 Filament Control PC Board

This section describes the procedures for checking the operation of the electron beam gun filament controller. Refer to drawing 193-100-602.

1. The system should be configured as described in sections 5.4.1 and 5.4.2. All circuit breakers should be off.

2. Turn on the MAIN and CONTROL circuit breakers. Check the +/- 15-volt power supply board mounted in the control chassis as described in section 5.3.3.

3. Place the oscilloscope probe on pin 6 of A1 (refer to DWG 193-100-603).

4. Turn on the MAIN and CONTROL circuit breakers. Slowly raise the test current and observe that the output of A1 varies from 0 to +10 volts.

5. Place the probe on pin 6 of A3. Observe that the signal varies 0 to –10 volts as the EMISSION CONTROL potentiometer is turned through its entire range of adjustment.

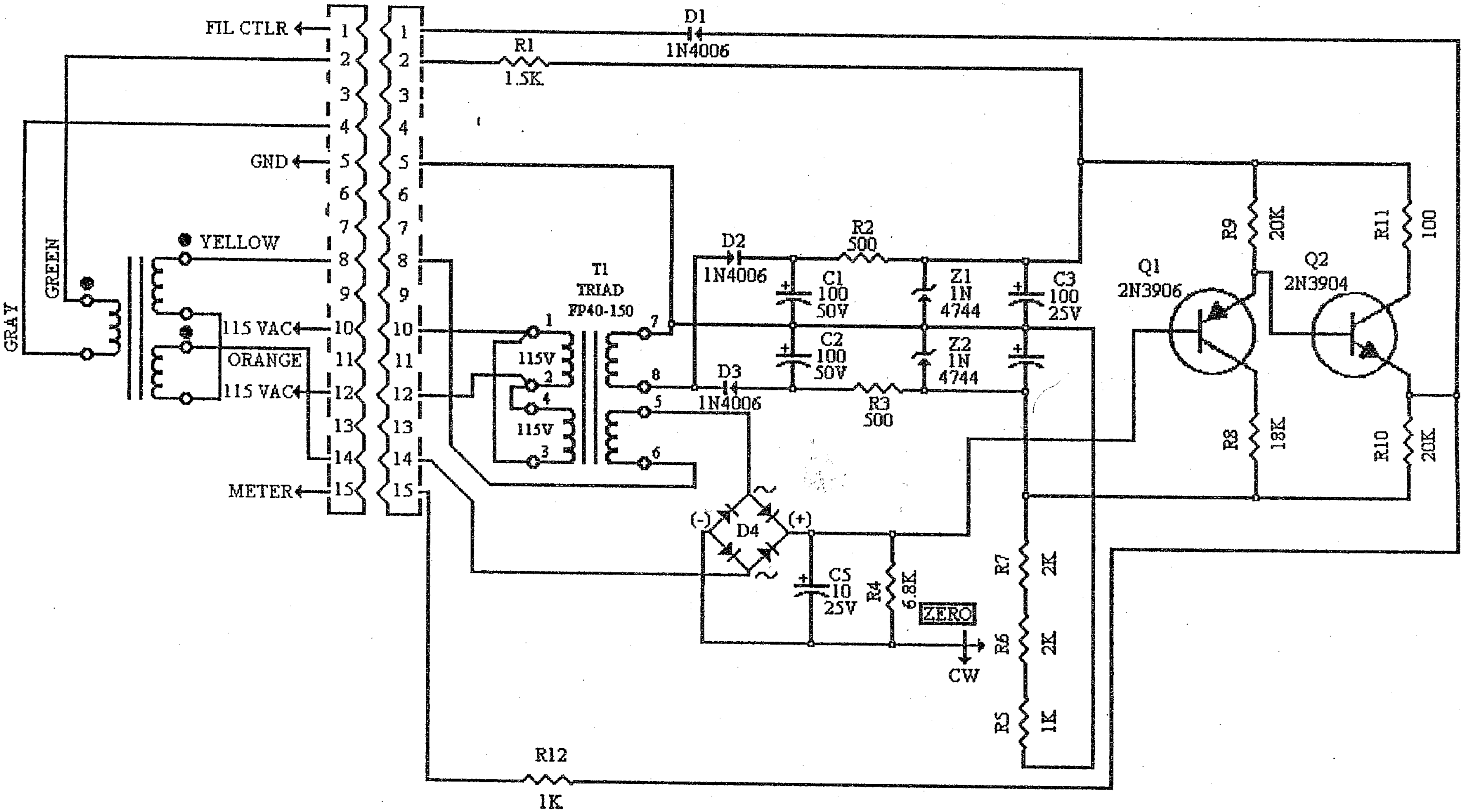
6. Place the probe on pin 6 of A2. Start this test with the EMISSION pot fully counter-clockwise and the test signal at zero. The output of A3 under these conditions should be approximately zero. Slowly turn the EMISSION pot clockwise. The signal at pin 6 will swing positive. When it has reached a maximum, stop turning the potentiometer. Slowly increase the test current. At some current, the signal should swing from a positive maximum to a negative maximum (approximately +/- 12 volts).

7. Check once again that the high voltage output leads from the power supply are disconnected and that the free ends are grounded. Also be sure that the power supply is completely closed (all panels, sides and top are installed).

8. Place the oscilloscope probe on pin 6 of A6. The voltage should be zero with the high voltage off. Turn on the high voltage and raise it to 4KV higher. The voltage at pin 6 should swing positive. Turn off the high voltage.

9. Place the scope prove on pin 6 of A7. With the high voltage off, the signal should be approximately –12 volts. When high voltage is turned on, this voltage should swing to +12 volts.

10. This signal drives Q2, which is used to discharge the energy stored in C11. Place the probe on the collector of Q2. When high voltage is off, Q2 should be turned off and the signal at its collector should be very near zero. When high voltage is on, Q2 will be turned off and C11 will charge exponentially



Thermionics Labratory Inc.

Transductor Amplifier

Drawing #192-999-962

5.4.4 Filament Control PC Board

This section describes the procedures for checking the operation of the electron beam gun filament controller. Refer to drawing 193-100-602.

1. The system should be configured as described in sections 5.4.1 and 5.4.2. All circuit breakers should be off.

2. Turn on the MAIN and CONTROL circuit breakers. Check the +/- 15-volt power supply board mounted in the control chassis as described in section 5.3.3.

3. Place the oscilloscope probe on pin 6 of A1 (refer to DWG 193-100-603).

4. Turn on the MAIN and CONTROL circuit breakers. Slowly raise the test current and observe that the output of A1 varies from 0 to +10 volts.

5. Place the probe on pin 6 of A3. Observe that the signal varies 0 to –10 volts as the EMISSION CONTROL potentiometer is turned through its entire range of adjustment.

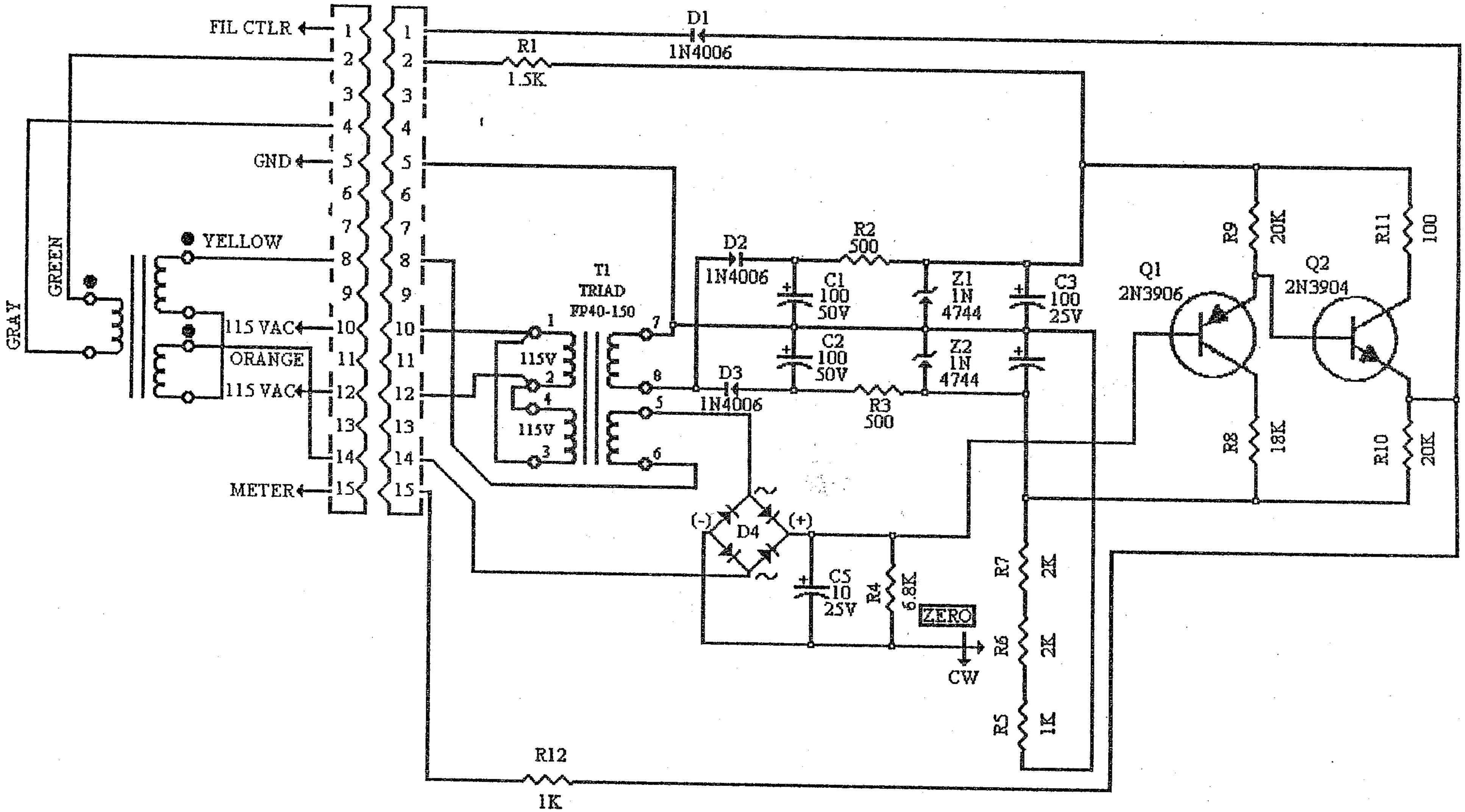
6. Place the probe on pin 6 of A2. Start this test with the EMISSION pot fully counter-clockwise and the test signal at zero. The output of A3 under these conditions should be approximately zero. Slowly turn the EMISSION pot clockwise. The signal at pin 6 will swing positive. When it has reached a maximum, stop turning the potentiometer. Slowly increase the test current. At some current, the signal should swing from a positive maximum to a negative maximum (approximately +/- 12 volts).

7. Check once again that the high voltage output leads from the power supply are disconnected and that the free ends are grounded. Also be sure that the power supply is completely closed (all panels, sides and top are installed).

8. Place the oscilloscope probe on pin 6 of A6. The voltage should be zero with the high voltage off. Turn on the high voltage and raise it to 4KV higher. The voltage at pin 6 should swing positive. Turn off the high voltage.

9. Place the scope prove on pin 6 of A7. With the high voltage off, the signal should be approximately –12 volts. When high voltage is turned on, this voltage should swing to +12 volts.

10. This signal drives Q2, which is used to discharge the energy stored in C11. Place the probe on the collector of Q2. When high voltage is off, Q2 should be turned off and the signal at its collector should be very near zero. When high voltage is on, Q2 will be turned off and C11 will charge exponentially



Thermionics Labratory Inc.

Transductor Amplifier

Drawing #192-999-962

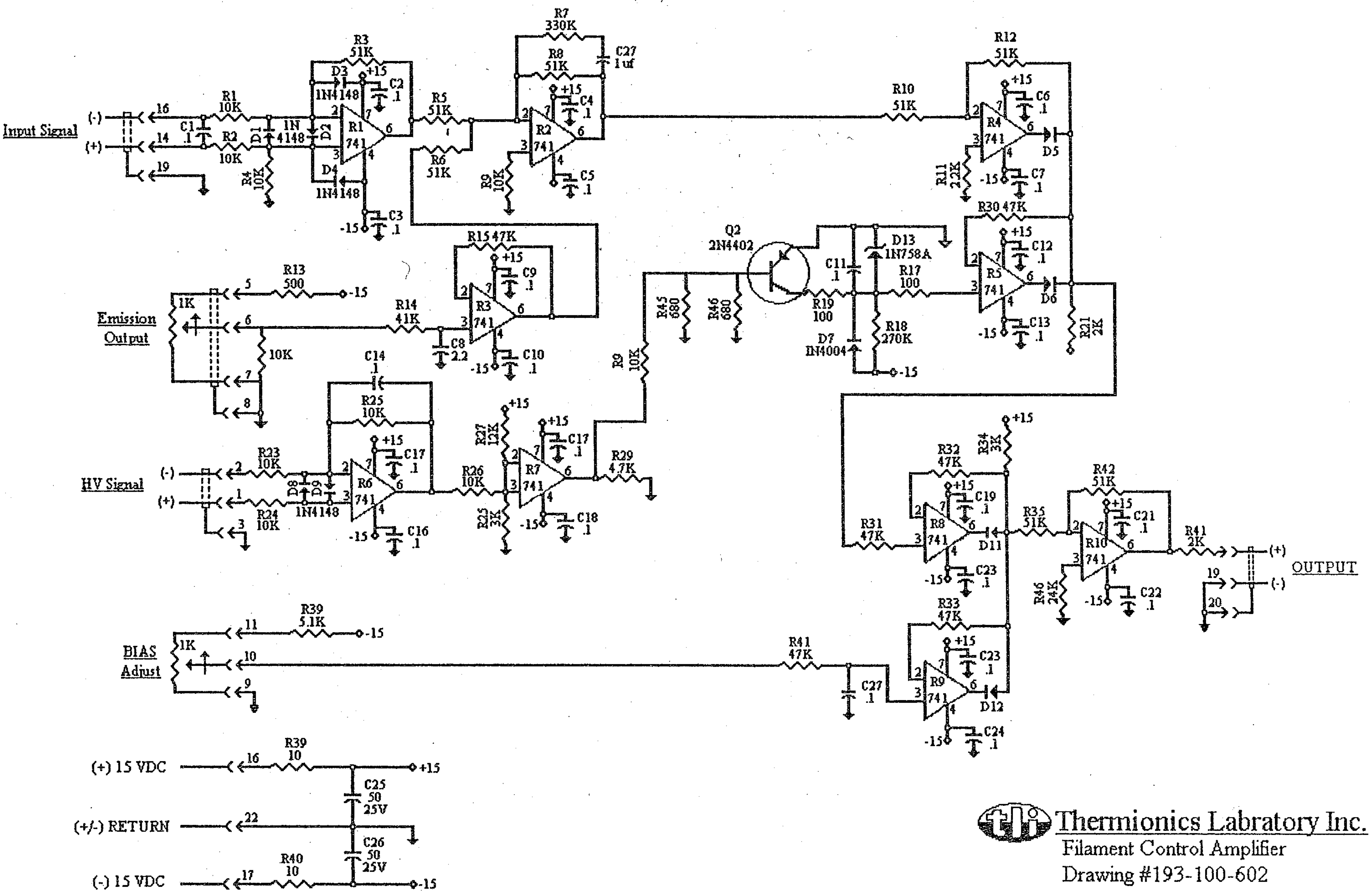
through R18 to a final value of approximately –10 volts. This signal is applied to the non-inverting input of A5.

11. Place the probe on the junction (cathode) of D5 and D6. With the test current zero, the EMISSION potentiometer set at minimum and high voltage off, the signal should be zero. When high voltage is turned on, this voltage will remain at zero until the emission pot is turned clockwise. The signal will then swing negative as a function of the potentiometer position. As the test current is increased, the signal will swing positive.

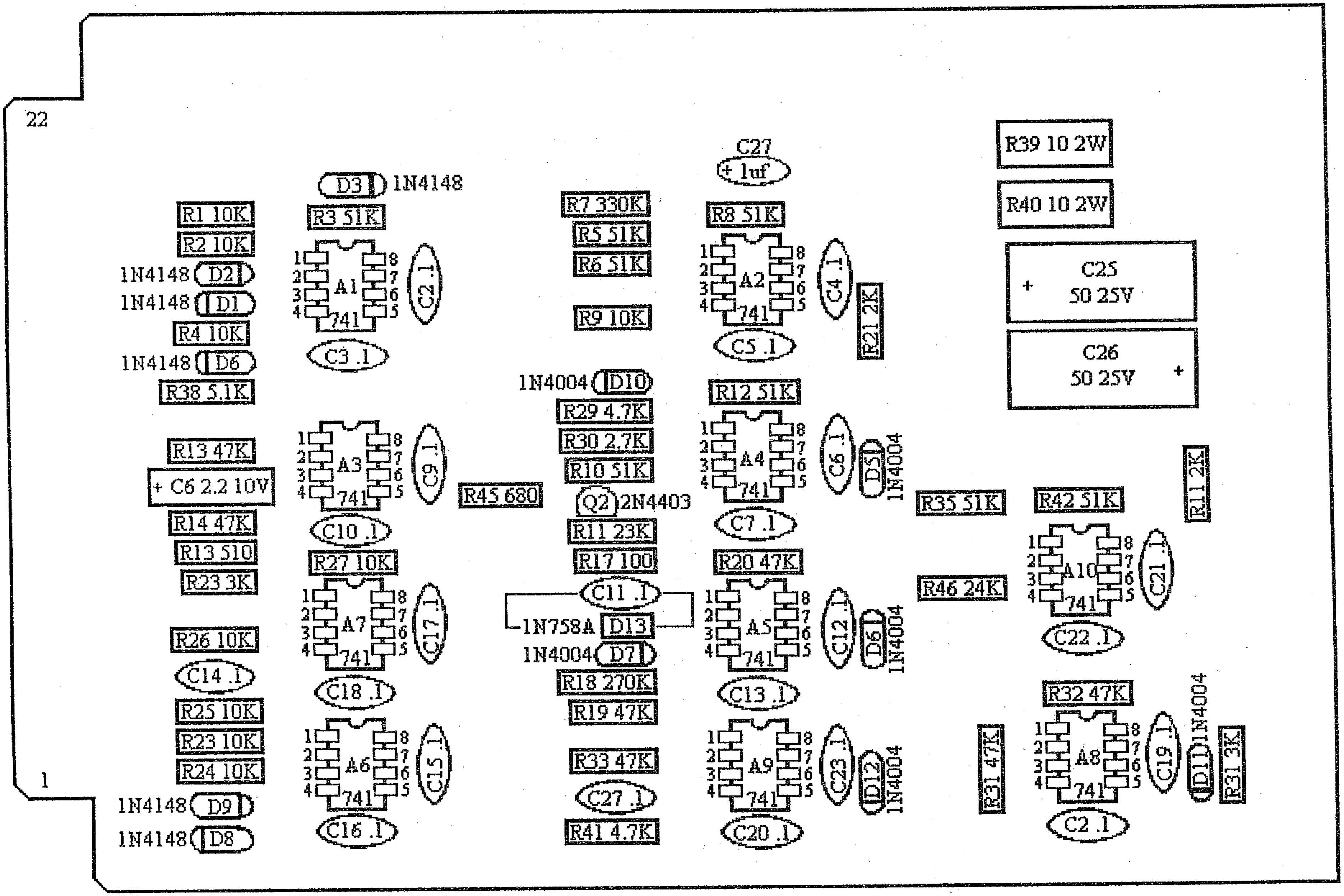
12. Place the probe on the junction of the anodes of D11 and D12. Repeat step 10 and observe that the signal will swing 0 to 12 volts negative.

13. Place the probe on pin 6 of A10. Repeat the procedure described in step 10 and observe that the signal varies from zero to 10 volts positive.

This completes the test of the filament controller amplifier.



Thermionics Laboratory Inc.
Filament Control Amplifier
Drawing #193-100-602



Thermionics Labratory Inc.

Filament Controller Componet Layout

Drawing #193-100-642

5.4.5 Gun Filament Circuit

This section describes a procedure for testing the operation of the electron beam gun filament circuit. The preparation for these tests is provided in section 5.4.1. Check to make sure the high voltage leads are still disconnected from the power supply and the free end of theses leads are connected to ground.

1. Pump the vacuum system down to operating pressure.

2. Turn on all circuit breakers.

3. Turn the EMISSION potentiometer fully counter-clockwise and place the MODE switch in the MANUAL position.

4. Close the high voltage and emission interlock strings and turn on the high voltage. Set its level greater then 4KV.

5. Turn on the gun filaments and look at the gun to be sure there is no filament glow. If there is, turn off the gun filament immediately. Check for a shorted SCR or transient suppressor.

6. If there is no filament glow, very slowly increase the EMISSION adjust potentiometer. At some point the gun filaments will start glowing. Turn of the filament immediately.

This completes the test of the gun filament circuit.

5.4.6 Conclusion

This section describes the procedure for "buttoning" up the power supply and making it ready for normal operation.

1. Turn off the primary source of power.

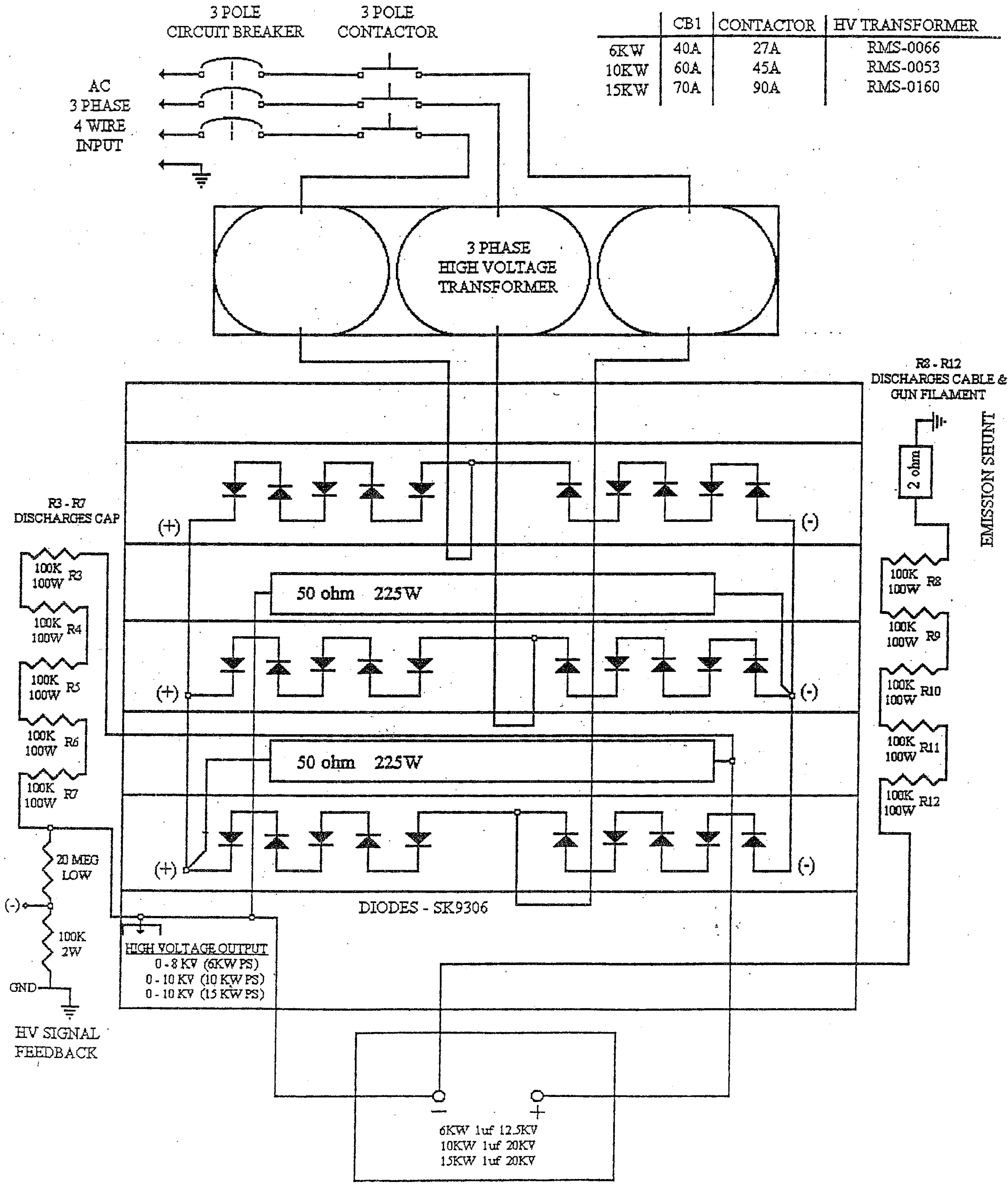
2. Replace the filament transformer enclosure cover and mount the assembly on the vacuum tank support structure.

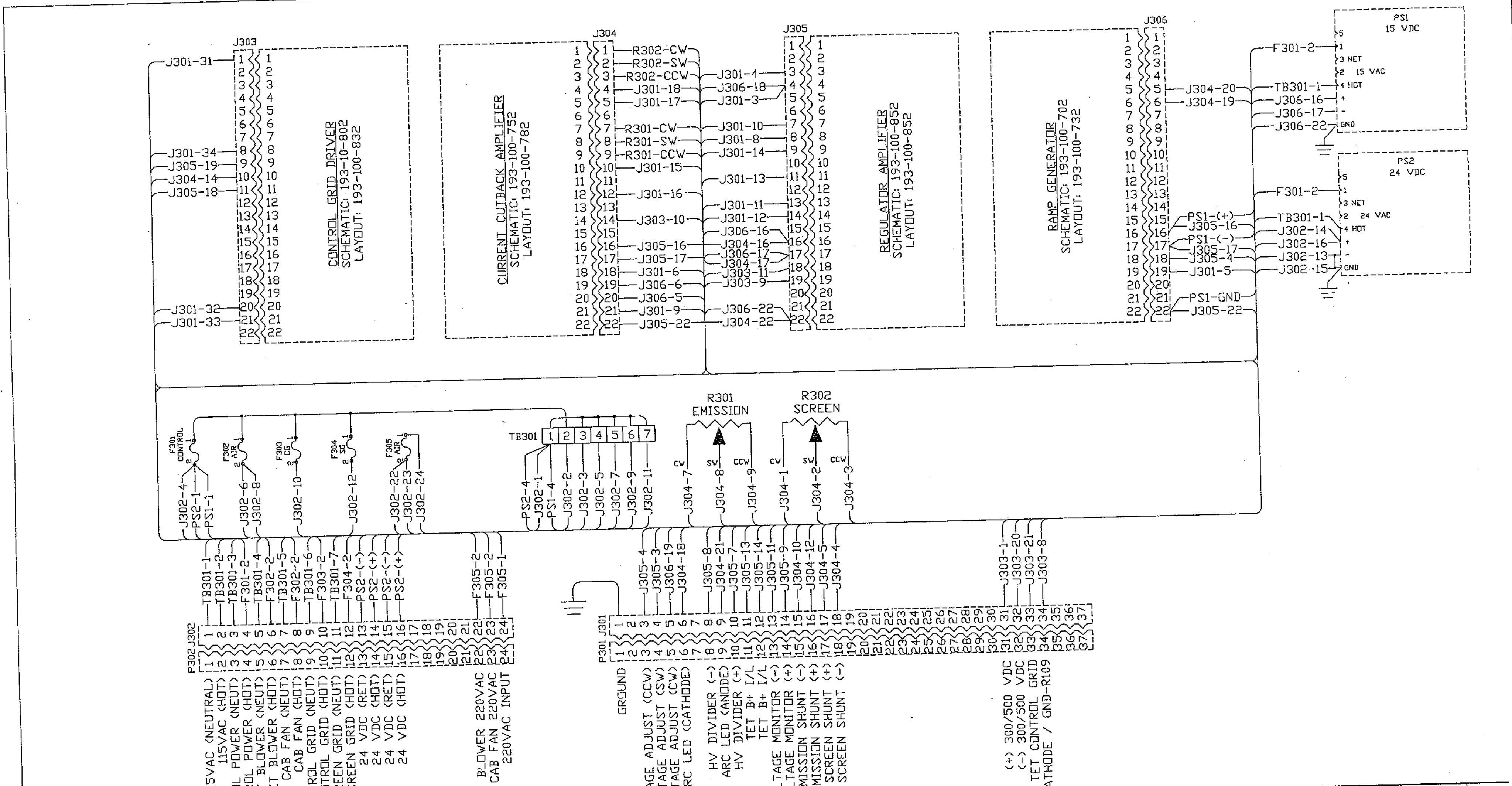
3. Replace the top on the control chassis and mount the assembly in the control rack.

4. Remove the rear air filter and connect the high voltage leads to the insulated stud. Replace the air filter.

The power supply is now ready for normal operation.

	CB1	CONTACTOR	HV TRANSFORMER
6KW	40A	27A	RMS-0066
10KW	60A	45A	RMS-0053
15KW	70A	90A	RMS-0160





ITEM NO.	QTY	PART / IDENT NUMBER	DESCRIPTION	REMARKS
			LIST OF MATERIALS	

NEXT ASSEMBLY

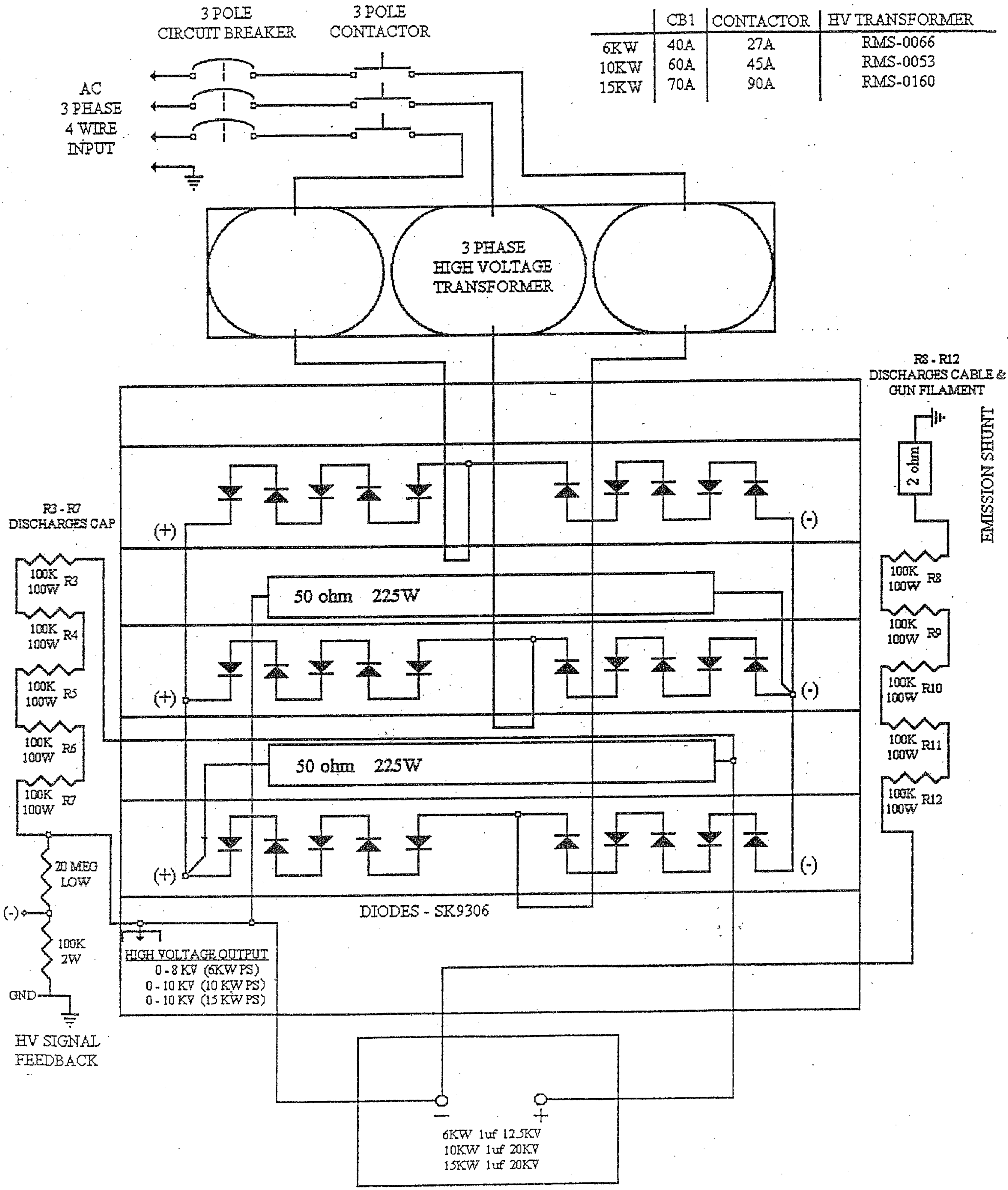
UNLESS OTHERWISE SPECIFIED
SURFACE FINISH ✓ | X ±.1, XX ±.01, XXX±.005, FRAC± | ANGLES ± 1/2°
DO NOT SCALE DRAWING

DRAWN: K.STANDRIDGE
DESIGNER
CHECKED
APPROVED
RELEASED
MATERIAL:
FINISH:

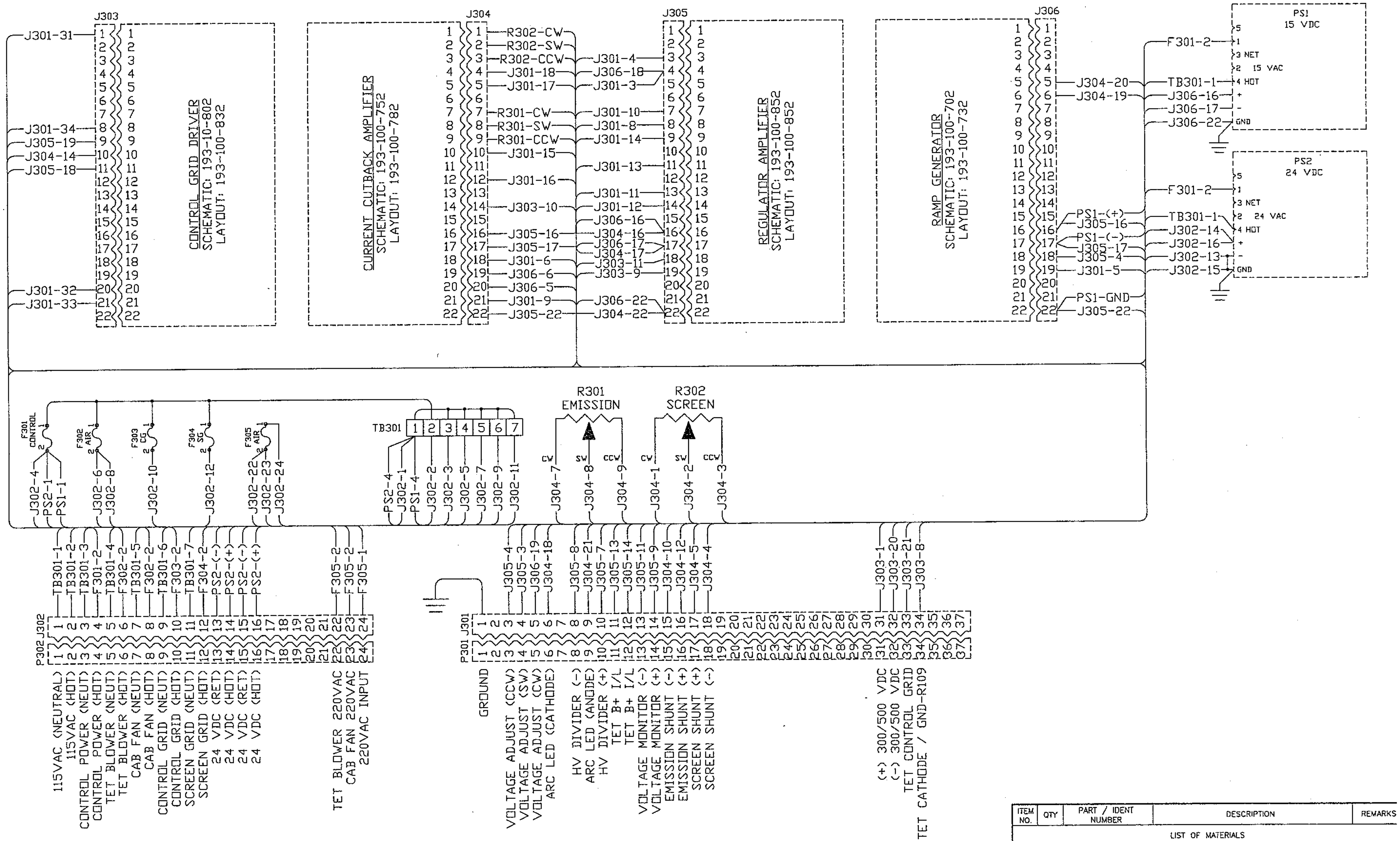
thermionics laboratory, inc.
999 Beecher Street San Leandro, Ca. 94577

WIRING DIAGRAM
PC BOARD CHASSIS

B | 193-100-033 | REV A
Scale X | Sheet 1 OF 1



	CB1	CONTACTOR	HV TRANSFORMER
6KW	40A	27A	RMS-0066
10KW	60A	45A	RMS-0053
15KW	70A	90A	RMS-0160



ITEM NO.	QTY	PART / IDENT NUMBER	DESCRIPTION	REMARKS

LIST OF MATERIALS

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CHECKED		
APPROVED		
RELEASED		
MATERIAL:		WIRING DIAGRAM PC BOARD CHASSIS
FINISH:		B — 193-100-033 — REV A

NEXT ASSEMBLY

UNLESS OTHERWISE SPECIFIED

SURFACE FINISH		ANGLES
√	.X ±.1 .XX ±.01 .XXX±.005 FRAC±	± 1/2°

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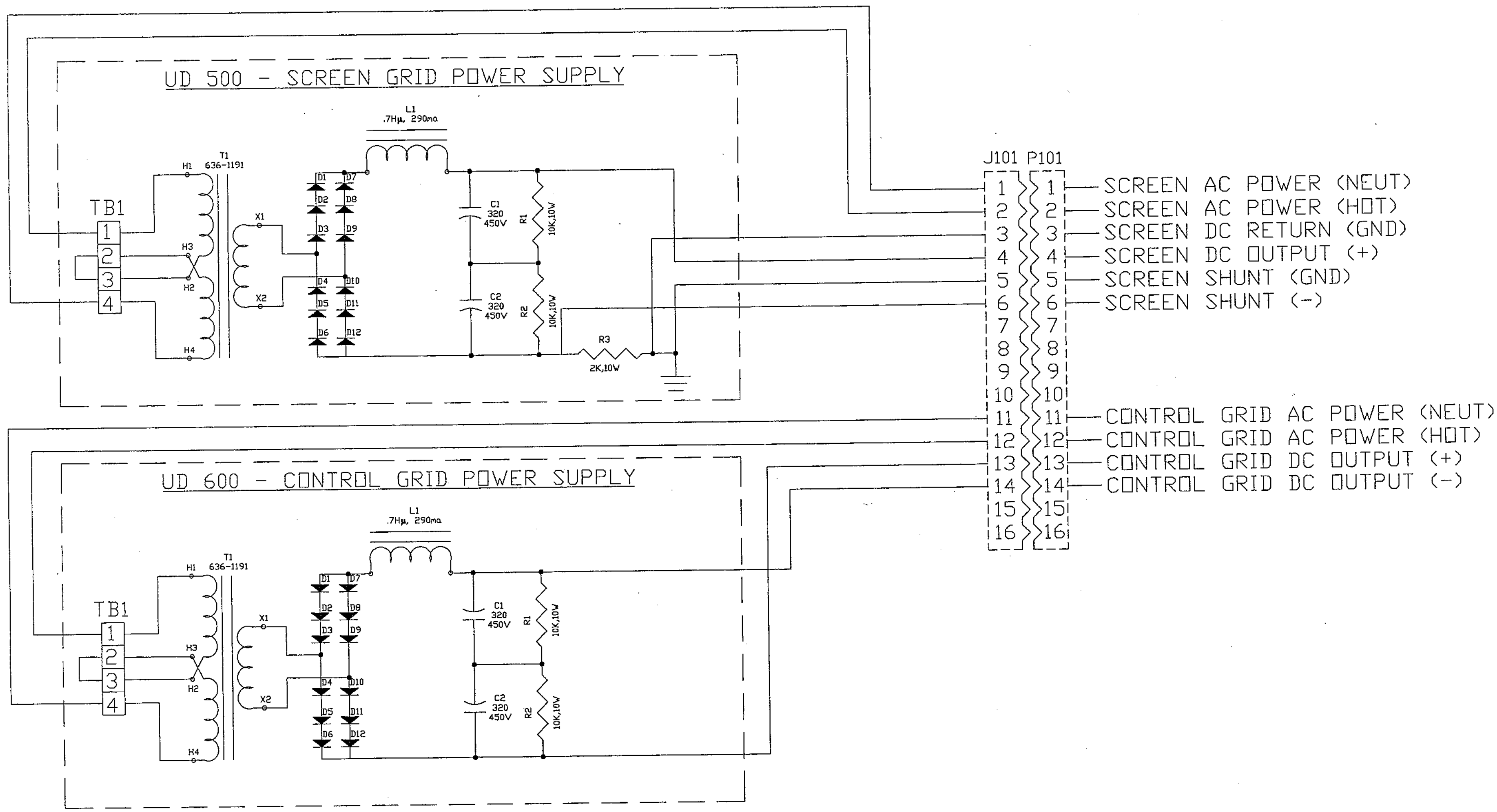

NOTES:

6KW:

TB1 JUMPERS 2-3

UD600 OUTPUT: -250VDC

UD500 OUTPUT: ±250VDC

10/15KW:

TB1 JUMPERS 1-2 & 3-4

UD600 OUTPUT: -500VDC

UD500 OUTPUT: ±500VDC

ITEM NO.	QTY	PART / IDENT NUMBER	DESCRIPTION	REMARKS
			LIST OF MATERIALS	

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DESIGNER	
CHECKED	
APPROVED	
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MATERIAL:	
FINISH:	

NEXT ASSEMBLY

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SURFACE FINISH ✓ | .X ±.1 .XX ±.01 .XXX±.005 FRAC± | ANGLES ± 1/2°

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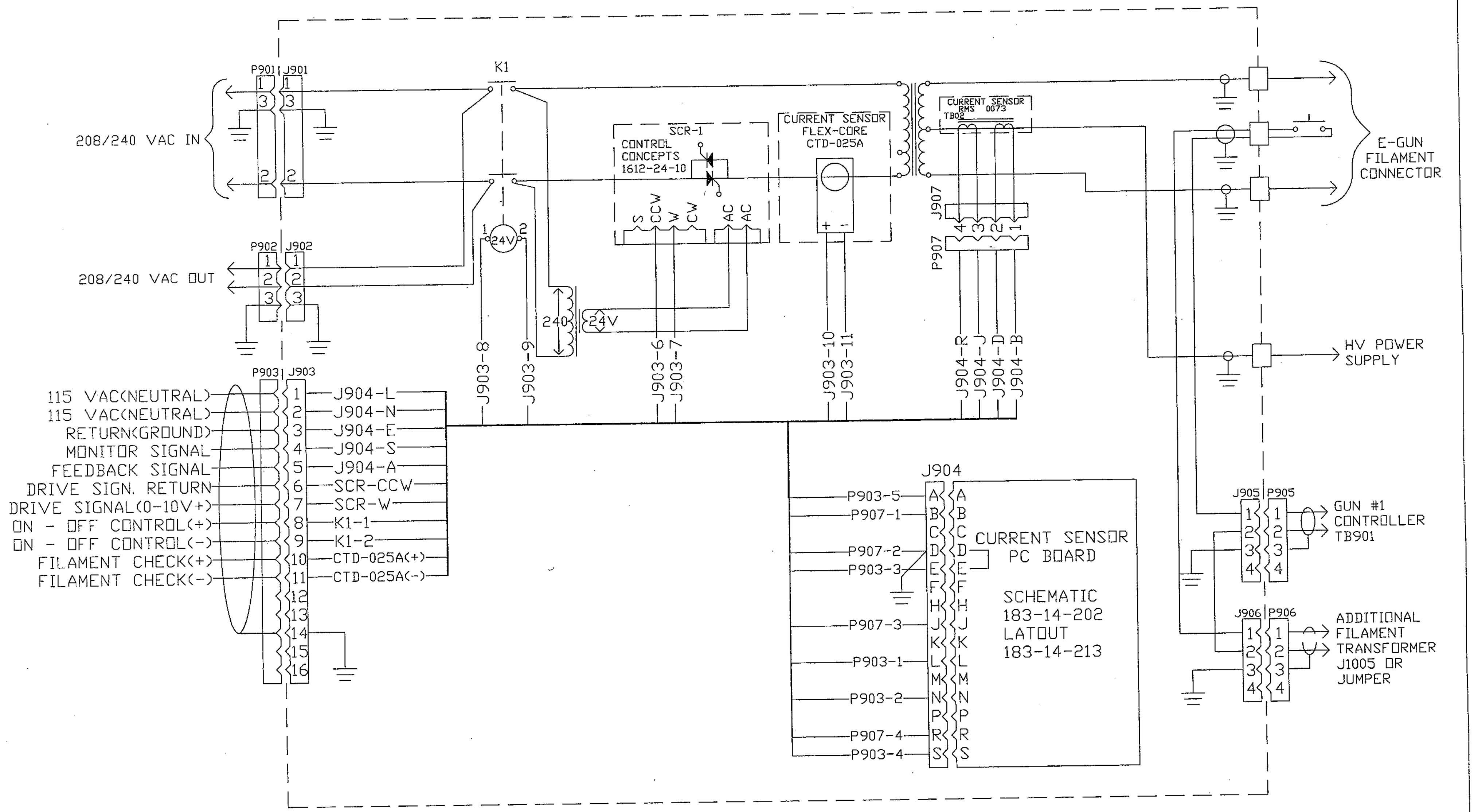
WIRING DIAGRAM
SCREEN / CG POWER SUPPLIES

A | 193-999-023 | REV A

Scale X | Sheet 1 OF 1



ITEM NO.	QTY	PART / IDENT NUMBER	DESCRIPTION	REMARKS

LIST OF MATERIALS

DRAWN	K.STANDRIDGE
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APPROVED	
RELEASED	
MATERIAL:	
FINISH:	

NEXT ASSEMBLY

UNLESS OTHERWISE SPECIFIED

SURFACE FINISH		ANGLES
123√	.X ±.1 .XX ±.01 .XXX±.005 FRAC±	± 1/2°

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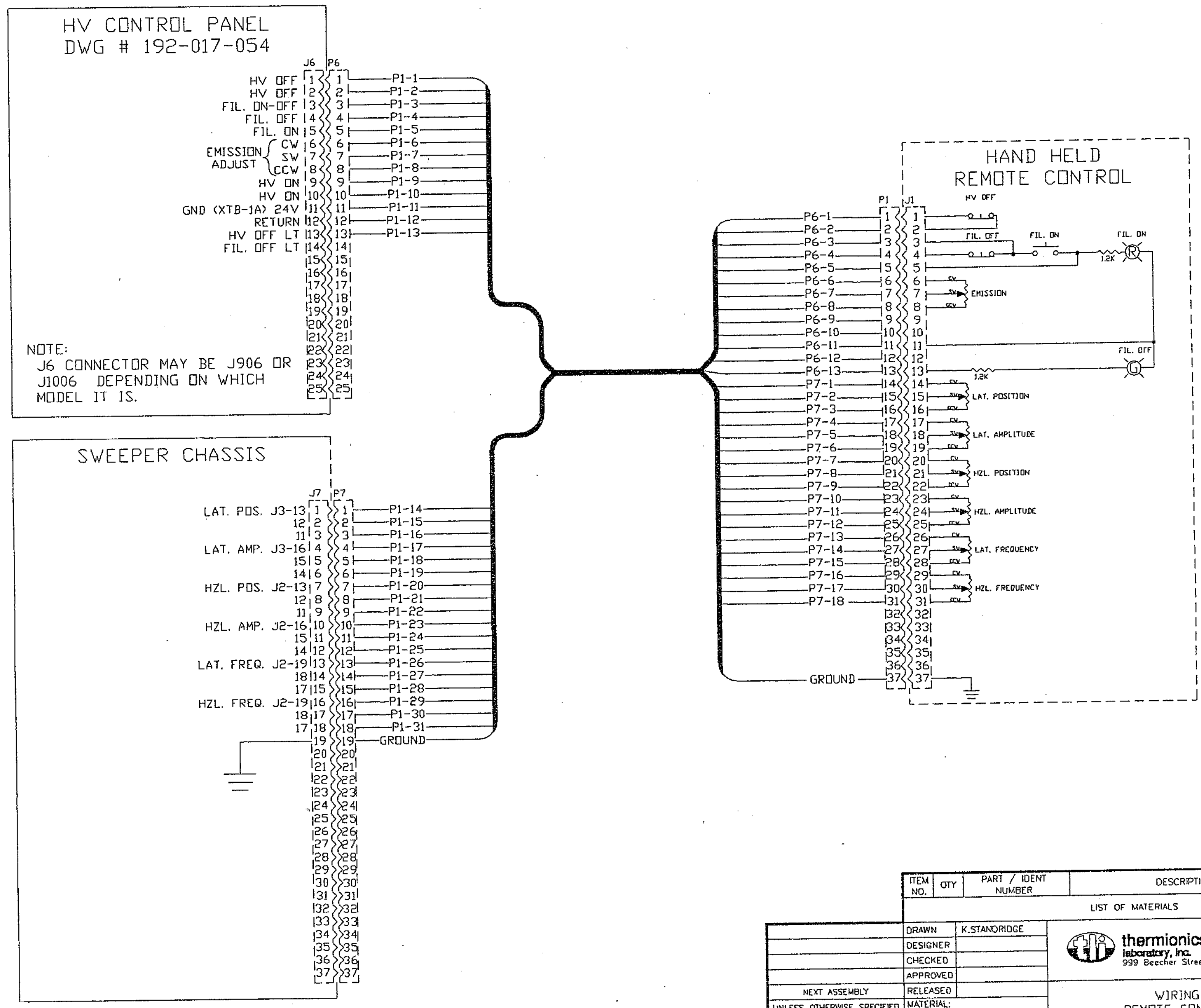
WIRING DIAGRAM
ADDITIONAL FIL XFRMR EMCLOSURE

A | 192-017-073 | REV A

Scale X | Sheet 1 OF 1



ITEM NO.	QTY	PART / IDENT NUMBER	DESCRIPTION	REMARKS

LIST OF MATERIALS

DRAWN	K.STANDRIDGE
DESIGNER	
CHECKED	
APPROVED	
RELEASED	

NEXT ASSEMBLY

UNLESS OTHERWISE SPECIFIED

SURFACE FINISH 123√ | X ±.1 .XX ±.01 .XXX±.005 FRAC± | ANGLES ± 1/2°

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MATERIAL: ?

FINISH: ?

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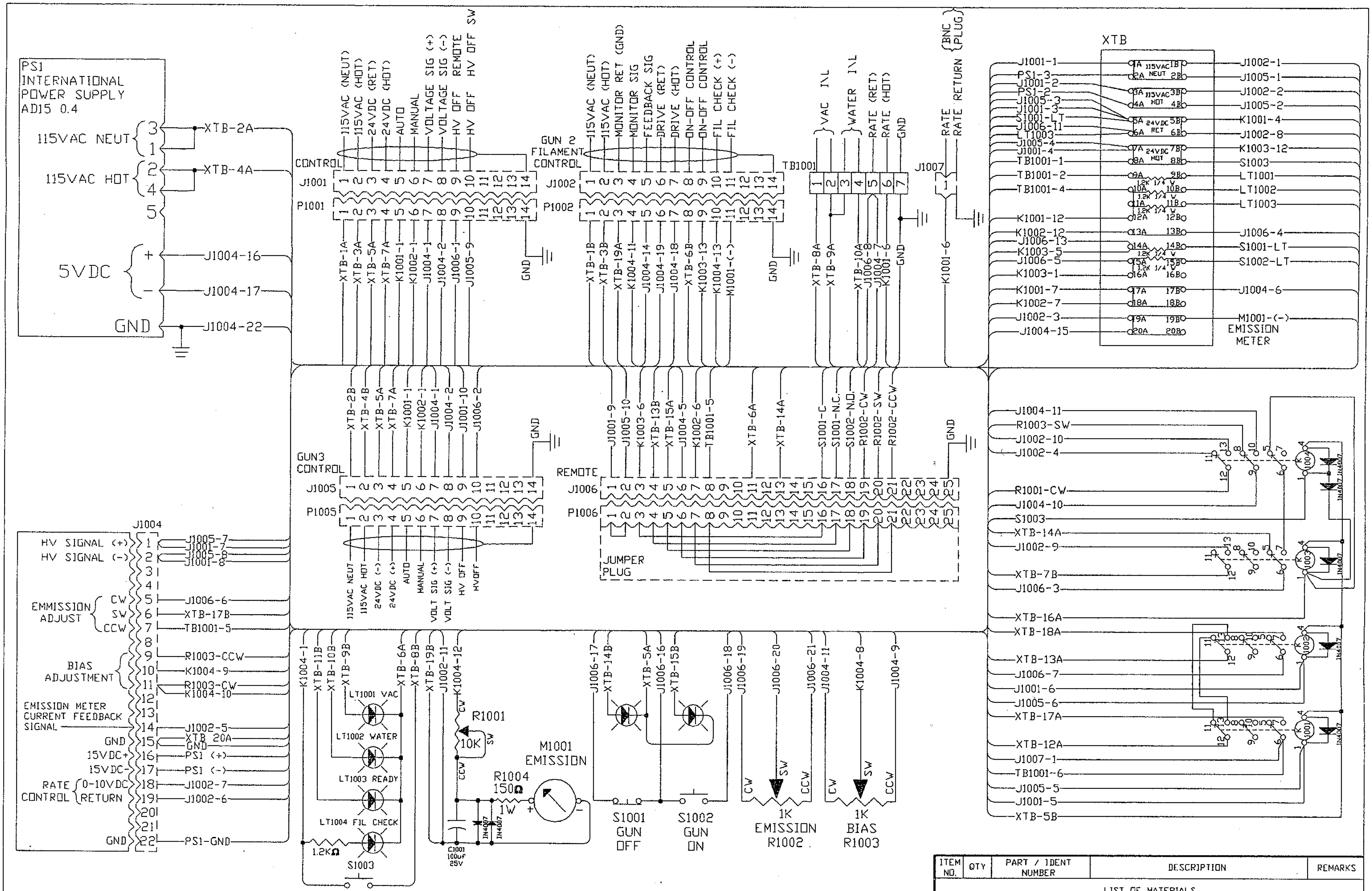
WIRING DIAGRAM
REMOTE CONTROL SYSTEM

A | 193-100-053 | REV A

Scale X | Sheet 1 OF 1



ITEM NO.	QTY	PART / IDENT NUMBER	DESCRIPTION	REMARKS

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DESIGNER	
CHECKED	
APPROVED	
RELEASED	
MATERIAL:	
FINISH:	

NEXT ASSEMBLY

UNLESS OTHERWISE SPECIFIED

SURFACE FINISH	X ±.1 XX ±.01 XXX± .005 FRAC±	ANGLES ± 1/2°
✓		

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HV INTERLOCK SOURCE #2 CONTROLLER

A	192-017-0648	REV A
Scale X		Sheet 1 OF 1